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Companion animals and human
well-being: an investigation of the
effects on cardiovascular reactivity.

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List of Abbreviations

ACTH	Adrenocoticotrophic hormone
ANS	Autonomic nervous system
BMI	Body mass index
CASE	Co-operative award in science and engineering
CAST	Cardiac arrhythmia suppression trial
CHD	Coronary heart disease
CNS	Central nervous system
CRF	Corticotrophin releasing factor
DBP	Diastolic blood pressure
ECQ	Emotional control questionnaire
ESRC	Economic and social research council
GAS	General adaptation syndrome
GHQ	General health questionnaire
GSR	Galvanic skin response
HPA	Hypothalamo-pituitary adrenal
HR	Heart rate
MAP	Mean arterial pressure
MI	Myocardial infarction
POMC	Propiomelanocortin
PSI	Palmar Sweat Index
QRI	Quality of relationships inventory
SBP	Systolic blood pressure
SCD	Sudden cardiac death

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I would like to dedicate this thesis to Jessica Dunn, (1912-1997).

Declarations

The first experiment was designed jointly by the author and June McNicholas in collaboration with Joanne Fisher and Aileen Mienke. Data collection and analysis reported in this thesis is the author's own work. In all other respects, material presented in this thesis is entirely the work of the author and has not been presented for a degree or similar purpose before.

The use of animals and testing procedures were approved by the Ethics Committee of the Psychology Department, University of Warwick. No animal was harmed during the course of the research.

Chapter 4 draws on material presented at the 10th Conference of the European Health Psychology Society, Dublin, September 1996.

Material in Section 4.3.2 on effects of stroking pets on cardiovascular activity was presented at the 8th International Conference on Human-Animal Interactions, Prague, September 1998.

The results of the first experiment were presented at the International Society for Anthrozoology Conference, Cambridge, UK, July 1996.

The results of the second and third experiments and issues of baseline assessment discussed in Section 5.3.2.3 were presented at the 8th International Conference on Human-Animal Interactions, Prague, September 1998.

Summary

This thesis examines effects of companion animals on human cardiovascular reactivity. An examination of previous research investigating effects of companion animals on human cardiovascular reactivity suggested that previous mixed and mainly non-significant results in this area might be due to failures in methodology. This led to the development of recommendations for future studies.

Three studies are presented which examined the effect of presence of an unfamiliar dog on participants' cardiovascular levels during a standardised reactivity study. The consistent finding from these studies was that the presence of an unfamiliar dog had no discernible effects on cardiovascular levels throughout the experiment (baseline and task levels combined) or on reactivity to stressors (difference between task and baseline levels).

The fourth study investigated the effect of presence of the participants own pet on cardiovascular levels during a reactivity study. The study also included a condition of human companion presence. The results of the study indicate significant moderation of reactivity from the presence of both a pet dog and a human friend. The design of the study allows elimination of certain explanations such as differential vocal styles, distraction, threat of setting and perception of the experimenter.

Whether social support is the mechanism which accounts for stress moderation in either companion condition is debatable. However in the case of pet dogs, it is argued that presence of ones pet during an everyday setting where one encounters stressful events would occur too infrequently to provide regular moderation of the stress response in the manner which has been proposed to lead to health benefits.

Chapter One

Thesis Introduction

1.1 Introduction

Historically, animals have been kept purely for functional purposes, however, there now exists the parallel phenomena of pet keeping (Serpell, 1996). Pets have no functional use but to exist for their owner's gratification. They are given special status and frequently kept in the home, despite a wide variety of disadvantages including financial costs, adverse health outcomes and lifestyle constraints (MacCallum, Beaumont, & Mackay, 1992; Plaut, Zimmerman, & Goldstien, 1996).

Despite the obvious disadvantages, the phenomenon of pet keeping is widespread and many people choose to keep pets. Pets are present in approximately 50% of homes in the UK (Office for National Statistics, 1998) and there is a similar situation in France, 55% (Digard, 1994), the USA, 56% and Australia, 66% pet owning households (McHarg, Baldock, Heady, & Robinson, 1995). Households with cats and dogs are the most frequent. In the UK, in 1998, there were estimated to be 8.0 million cats, 6.9 million dogs, 3 million birds, 1.4 million rabbits, 1 million hamsters, 800,000 guinea pigs and 28.2 million fish, as well as, many other more exotic animals kept as pets (Pet Food Manufacturers' Association, 1999). Thus, the person-pet relationship is not a rare occurrence and, given its one-sided cost to the human partner, requires some explanation. Presumably pets supply some real or perceived benefits to their owners which outweigh their real or perceived disadvantages.

In addition to companionship benefits often attributed to pets, it has been suggested that pet ownership is associated with health benefits (e.g. Beck & Meyers, 1996; Edney, 1995). Although the evidence in this area is not unequivocal in its support for

this suggestion, the variety of the research in this area, and public receptiveness, has resulted in a general belief that pets are good for health. Articles in newspapers and magazines heralded with titles such as '*pets are good for you*' (Hawkes, 1993), '*secret power of pets*' (Vines, 1993) and '*the healing power of pets*' (Browne, 1996) reinforce the accepted nature of this belief.

However, a dichotomy exists in the scientific literature, with some researchers accepting the existence of health benefits and lamenting the general medical disinterest (Anderson & Headey, 1995; Patronek & Glickman, 1993; Rowan, 1995) whereas others, if they express interest at all, show more restraint and wait for the provision of more conclusive proof (Allen, 1997; Culliton, 1987).

Regardless of whether pet ownership is associated with human health benefits, the mechanisms which might result in this association, are relatively understudied. It should be recognised that even if pet-ownership is associated with enhanced human health, this may not imply that pet ownership causally produces these benefits (McNicholas & Collis, 1998a). It is possible that pet ownership may be associated with other factors associated with health benefits such as personality traits which moderate the stress-illness relationship or a higher socioeconomic status. If this were the case, then it would not imply a causal effect of pets on human health. For animals which require outdoor exercise or act as a hobby to their owners, the additional human relationships this may lead to, or the exercise their owners are encouraged to take, may also have health benefits. This could be seen as an indirect effect of pet ownership, which although due to the pet, is an effect which might not be restricted to pets.

Alternatively, the effect on health may lie in the relationship that the owner has with their pet. Many pet-owners report the person-pet relationship to be of a similar level of intensity to human-human relationships (Digard, 1994; MacCallum *et al.*, 1992; Serpell, 1996). It is likely that, in relating to animals, humans will borrow from previously existing schemas developed for human-human relationships (Collis &

McNicholas, 1998) and thus similar effects might be noted from human-companion animal relationships as are for human-human relationships. In the context of health benefits, this has particular relevance due to the strongly established connection between quantity and quality of human-human relationships and human health (Cohen & Wills, 1985; House, Landis, & Umberson, 1988a). Thus the person-pet relationship may provide support and companionship in a manner which is able to buffer the human partner against stress, alleviate loneliness and provide companionship.

Of most relevance to this PhD is the suggestion that animals might have physiological effects on the humans they come into contact with (Friedmann, 1995). Researchers have examined whether watching or stroking pets might be relaxing and reduce blood pressure. However the research in these areas does not provide evidence of acute effects on cardiovascular variables (Dunn, McNicholas, & Collis, 1998) and mechanisms relating to long term health benefits in the absence of acute effects have not been proposed.

A further physiological mechanism which has been examined is whether the presence of animals can moderate the cardiovascular stress responses of their owners or other people with whom they interact. This last suggestion is plausible, as a recent review has concluded that one mechanism by which human relationships may exert their benefits on human health, is via moderation of physiological stress reactivity (Uchino, Cacioppo, & Kiecolt-Glaser, 1996). However, to date, the research which has investigated the effects of pets on human physiological reactivity has produced mixed results, which do not allow this to be confidently accepted as a mechanism underlying health benefits.

The impetus for this research has come from an Economic and Social Research Council (ESRC) funded CASE (Co-operative Award in Science and Engineering) studentship to University of Warwick with the industrial partner Waltham Centre for Pet Nutrition. The brief was to investigate the experimental evidence on effects of

companion animals on human cardiovascular functioning, within the cardiovascular reactivity paradigm, with particular focus on the use of appropriate methodologies. It was hoped that more rigorous research in this area would conclusively establish whether there are physiological stress moderation effects of companion animals.

1.2 Organisation of the thesis

The theoretical background to the thesis is presented in Chapters 2, 3 and 4. The opening literature review, Chapter 2, details the field of stress and disease and particularly the research area of cardiovascular reactivity, which had been pre-determined as the methodology for this programme. It explains why cardiovascular reactivity in a laboratory setting would be expected to have an impact on health.

The following literature review chapter, Chapter 3, sets out what is currently known about the impact of human relationships on human health. In particular this chapter reviews the empirical evidence that human companion presence can moderate human cardiovascular reactivity and the recent suggestion that human relationships might exert their health benefits through physiological moderation of the stress response (Uchino *et al.*, 1996). This can be seen as the human analogue of the suggestion that pets produce health benefits by moderating their owners' reactivity to stress.

The third literature review, Chapter 4, examines the empirical evidence investigating the association between human-companion animal relationships and human health outcomes. The first half of this chapter evaluates the strength of evidence in each health outcome area. The second half of the chapter discusses various explanations which might account for the association of companion animals with human health benefits. Physiological stress moderation is but one of a number of mechanisms and should be considered in the light of other potentially more parsimonious explanations.

Chapter 5 critically reviews the empirical studies which have investigated the effects on human cardiovascular systems of the presence of companion animals. This chapter contrasts the methodology of companion animal studies with standards of mainstream cardiovascular reactivity research. Concerns with the state of methodology in companion animal research was one of the main reasons why this area was chosen for a PhD and thus this chapter enables the reader to gauge the mainstream level of methodological sophistication and evaluate the rigour of the companion animal studies.

The four empirical chapters take the exploration of this research area further. Studies one, two and three examined the effect of a dog unfamiliar to the participant on cardiovascular reactivity. The three studies become increasingly methodologically advanced in an effort to detect and investigate mechanisms which might account for moderation of cardiovascular reactivity to a stress task in a laboratory setting.

The first experiment was designed to provide an initial test of whether the presence of a companion animal reduces human cardiovascular reactivity to a laboratory stressor. Due to the industrial nature of the studentship, some aspects of this design were already set as the experiment was the second in a set of two studies for a separate project. As such, the study examined the impact of the presence of a canine companion who was not previously known to the human participant. Although this does not conflict with the direct effects hypothesis, which suggests that these effects are not limited to situations where the person has had a prior relationship with the companion animal, (Friedmann, 1995), it did limit its worth in informing what might be occurring in the context of a relationship between a human owner and their specific pet. However it was a pragmatic choice, given the limited number of participants living within a feasible travelling distance of the University and who would have animals which they and the animal would be happy about bringing to the university. This choice was in line with the majority of previous studies and starting testing with an unfamiliar dog who could be standardised amongst all sessions had its advantages.

The second study examined the effect of incorporating methodological improvements into assessment of baseline. The introduction to this study discusses how variation in baseline assessment might account for discrepancies in findings of previous published studies investigating effects of companion animals on cardiovascular reactivity.

The third study examines the possible effect of the presence of a dog affecting the level of social interaction between participant and experimenter. There is robust evidence to demonstrate that presence of dogs facilitates conversation between people in other settings (McNicholas & Collis, unpublished). Thus, it had been reasoned that presence of a companion animal in a research setting might also increase interaction between the humans present, i.e. the experimenter and participant (McNicholas, Dunn, Meinke, Fisher, & Collis, 1996). This increased rapport at the start of the experiment may reduce participant's subsequent reactivity to the stressors. However, if this explanation accounts for previous findings of reductions in cardiovascular activity seen in humans in the presence of unfamiliar dogs (Friedmann, Katcher, Thomas, Lynch, & Messent, 1983b; Locker, 1985), it suggests that the effect is an artefact of the experimental setting which would not generalise to pet owners with their own pets in every-day situations.

The fourth empirical study moves away from examining effects of unfamiliar dogs and examines potential stress moderation effects from the participant's own pet dog. Only one previous study (Allen, Blascovich, Tomaka, & Kelsey, 1991) has found a moderation of reactivity from the person's own pet. In Allen *et al.*'s experiment, a similar friend present condition was associated with higher reactivity than being alone. The finding of higher reactivity from the presence of a friend is in contrast to other studies which find the presence of a passive human companion to be associated with lower reactivity (Kamarck, Annunziato, & Amateau, 1995; Kamarck, Manuck, & Jennings, 1990; Kors, Linden, & Gerin, 1997). The failure of the friend condition to moderate reactivity may have been due to the effect of evaluation. However, given that moderation was not seen in the friend present group, Allen *et al.*'s experiment

does not allow an acceptance that similar mechanisms account for moderation of reactivity from human and canine companions. Therefore in the fourth experiment, the human presence was made non-evaluative to match the presumed non-evaluative nature of a pet's presence. In addition, subjective aspects of the experiment were examined to determine equivalence of conditions. This allowed a more sophisticated test of the proposal that moderation of reactivity from a canine companion is due to the same mechanism(s) as moderation of reactivity from a human companion.

A second aspect of the fourth experiment was to investigate recovery from the task. Although cardiovascular reactivity has been heavily studied, conditions affecting cardiovascular recovery have been relatively under examined, despite its relevance to health outcomes (Linden, Earle, Gerin, & Christenfeld, 1997). This final study therefore examined both reactivity and recovery to the task as a consequence of pet presence.

In chapter ten, the results of the empirical chapters are examined in the wider context of issues surrounding the investigation of the association between pet ownership and human health benefits. This chapter summarises the recommendations for methodological standards in future companion animal reactivity experiments; concludes on the future utility of studies investigating stress moderation from unfamiliar animals and examines the stress moderation effects of pets.

Chapter Two

Stress and Illness

2.1 Introduction

This chapter examines how stress might influence illness. The idea that psychological stress influences vulnerability to disease, has become part of popular wisdom and there is robust if not unequivocal evidence to support this notion. This chapter discusses the nature of stress and how it can lead to ill health. The chapter also introduces the cardiovascular reactivity paradigm: what it is, how it is researched, and how it adds to our understanding of the process of stress leading to illness.

2.2 Historical background

The concept of stress has received particular academic attention in the twentieth century. However, the recognition of illnesses related to emotional upset, nervous conditions and excessive worry has a longer history (e.g. Bible and Talmud references see Siegman, 1994). The foundations of our modern conceptualisation of stress can be traced to the work of Bernard (1813-1878), Cannon (1871-1945) and Selye (1907-1982).

Bernard (1878/1966) established one of the fundamental principles of physiology: that to function optimally an organism must hold relatively constant its internal environment despite changes in external conditions. As such, mechanisms exist to counter variations in physical states such as body temperature, blood sugar, pH or oxygen levels. Cannon (1926/1966; 1939) described this ability of the body to maintain certain set points of functioning as *homeostasis* and investigated the

physiological correlates of emotional responses such as fear and rage which he regarded as homeostatic responses to certain kinds of perceived threat. He theorised that in situations of fear or rage, adaptational responses would facilitate acute motor activity required either to flee the cause of fear or fight the cause of rage - the so called '*fight or flight*' response.

Cannon's work mainly focused on the adaptational nature of the fight or flight response, although he noted that frequently repeated or sustained responses might lead to pathology. Selye however, concentrated more fully on the pathological outcomes of endocrine responses to a sustained noxious stimuli without paying a great deal of attention to the role of emotional factors in this process.

Selye initially worked on rats. He became interested in a non-specific response triad of enlarged adrenal cortex, atrophied lymphatic structures and gastro-intestinal ulcers which he was able to provoke from tissue damage and seemingly many other noxious stimuli such as extreme cold, toxic injections, x-rays and infection (Selye, 1936). This reminded Selye of his observations of unwell humans with similar symptoms, where there appeared to be a general syndrome of sickness which was superimposed on many specific diseases (Selye, 1976). He believed that the response triad seen in experimental animals was the same as the non-specific syndrome of '*being sick*' seen in humans. To describe this phenomena, Selye borrowed from physics the term '*stress*' which he used to describe the results of these noxious demands upon the body.

Selye theorised that noxious stimuli affected some '*first mediators*' which activate the nervous system. The general physiological responses which then occur to counteract and adapt to the stressor use adaptation energy and over time may lead to exhaustion and disease. Selye's model of these changes in response to a sustained stressor - the general adaptation syndrome (GAS) - progressed through stages of alarm, resistance and finally exhaustion after prolonged exposure to the stressor. Pathologies would be

seen in the alarm stage and exhaustion stage of the response.

The work of both Cannon and Selye set the stage for the explosion of research on stress which followed. Central to this was a clarification of terminology. Selye's use of the word '*stress*' in a different manner to that of conventional physics (i.e. as the result of an input rather than a stimulus) and use at different times to indicate both input and response caused consternation amongst other researchers (Mason, 1975). Current writers, including Selye (1976), now use the term '*stressor*' to denote stimuli causing a stress response (Lovallo, 1997; Sapolsky, 1994). This terminology will be applied in this thesis. In this thesis, the term '*stress*' will be used to denote a mental process initiated by external conditions and / or internal mental processes and producing behavioural, emotional and systemic physiological responses, the '*stress response*', likely to enhance the body's ability to respond to the exceptional demands. The reasoning behind this definition will be considered in section 2.3.5, however first definitions will be given of the stages involved in this process.

2.3 Links between potential stressors and a stress response

Figure 2.1 represents the possible links between stressors and illness.

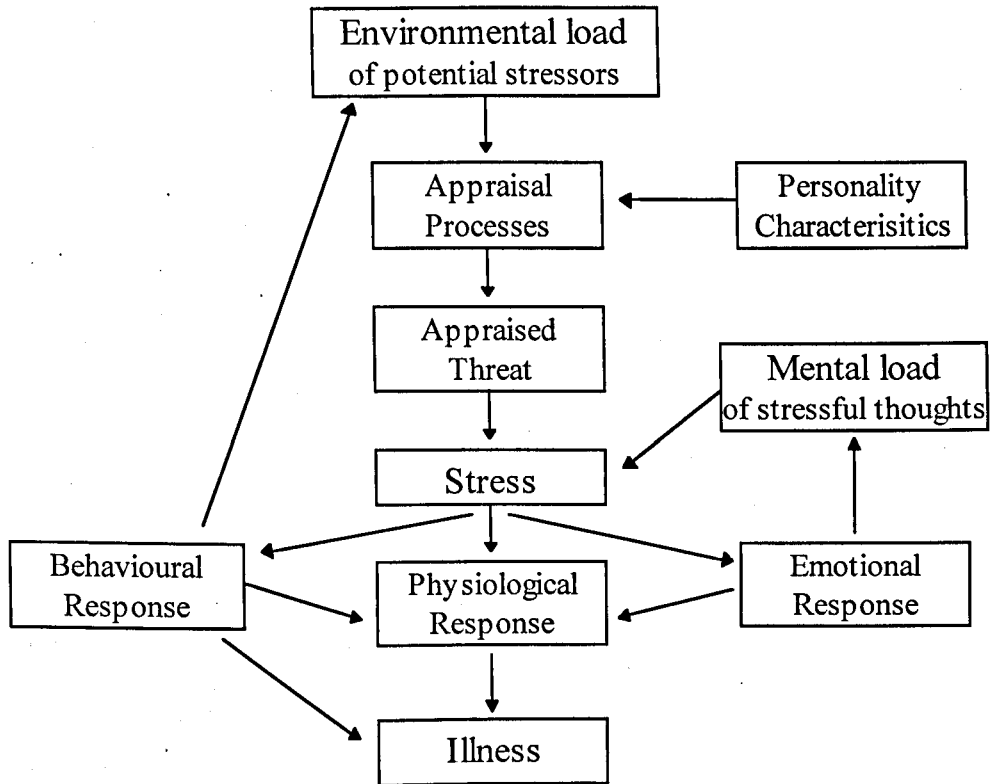


Figure 2.1 Links between stressors and illness.

2.3.1 Environmental load

The environmental load of potentially stressful events can be considered the life events and states which surround an organism. Physical stressors include starvation, dehydration, extremes of temperature, physical injury and infection, indeed many of the events studied by Selye. These are stimuli which damage the body, or where damage to the body may occur if they are not averted. Of more interest in this thesis are psychological stressors. These are events or states which do not involve a physical threat to an organism but which nevertheless produce a stress response. What is classed a psychological stressor, as will be discussed, is a somewhat arbitrary

definition. However in order to research the area, psychologists have come to a consensus agreement on a class of events and states which are likely to act as a stressor to most people.

Psychological stressors have been divided into major and minor events and acute and chronic stressors. Wheaton (1997) defined life events as acute stressors with a clear on-set and off-set, which generally start abruptly, and which progress to a resolution. Major acute events can include divorce, death of a loved one, or job loss. These however are rare events for most people. In contrast, minor acute events such as losing things, arguments with colleagues, social obligations and transport difficulties, can pose a source of stress on a daily basis. In some cases the regularity and pervasive nature of such minor events suggests that they are not merely a one off event but can be seen as one part of a chronic stressor (Kanner, Coyne, Schaefer, & Lazarus, 1981).

Chronic stressors, can be defined as developing slowly, often as insidious conditions, having a longer time course than events, having an enduring regularity in their occurrence or being intrinsic to daily roles and often not having a clear off-set or resolution (Wheaton, 1997). Chronic stressors in Wheaton's classification include *involuntary role inoccupancy* (i.e. being childless or out of a relationship when this is desired); *role occupancy strains* (i.e. caregiving for a relative); a *transition in roles* (i.e. becoming a single parent, developing a chronic illness) and *ambient stressors* (i.e. residential difficulties, time pressure, occupation stress). Factors such as race, socioeconomic status, family dysfunction, social isolation and living in a low socioeconomic status community may heavily determine the environmental load of chronic stressors (Adler *et al.*, 1994; Lynch, 1977; Taylor, Reppetti, & Seeman, 1997).

Although researchers attempt to distinguish between acute and chronic stressors, it is unclear whether this distinction is valid (Gottlieb, 1997). An acute event such as the death of a loved one may have an extended course of stress either side of the event and

chronic stressors may be punctuated by acute stressful events (Gottlieb, 1997; Pillow, Zautra, & Sandler, 1996). The terms chronic and acute have no absolute definition, they are only definable in relation to each other. Major and minor are likewise relative distinctions. As will be seen, many scales measuring life events contain a variety of items which cross classification boundaries. The more fundamental issues for health are probably the duration and magnitude of stressor impact through physiological, behavioural and emotional responses.

However, presuming that there may be a set of events or states which can be objectively defined stressful, various checklists have been developed which allow a degree of measurement of the environmental load of stressful events. The Holmes and Rahe (1967) Social Readjustment Rating Questionnaire, for example, includes event items such as '*death of spouse*' and '*Christmas*' in addition to items which might reflect more chronic stressors, i.e. '*trouble with in-laws*' or '*mortgage over \$10,000*'. Items on a hassles rating scale range from minor events '*misplacing or losing things*' to more chronic stressors such as; '*problems getting along with fellow workers*' and '*thoughts about death*' (from Kanner *et al.*, 1981). Items on Wheaton's (1997) chronic stress scale include, '*too much is expected of you by others*', '*someone in the family or a close friend has a long term illness or handicap*' and '*you are alone too much*'.

Life events checklists enable measurement of a subset of event or states which can be classified as likely to produce a stress response in people. However given the subjective nature of stress, they have been criticised on a number of fronts. First their content may be restrictive in under-including stressors pertinent to some socioeconomic, ethnic, sex or age groups (Rabkin & Struening, 1976). It would be difficult to envisage however, an instrument which contained all possible stressors for all peoples, whilst remaining within practical limits. Second, non events which cause distress by their non-occurrence or forecasts of future change are under-represented or excluded altogether (McLean & Link, 1994). Third, weighting of life events by objectively determined seriousness may be inadequate to capture an individual's

reaction to a stressor. These issues all surround the subjective nature of stress. However further concerns can be raised regarding the methodology. For example, retrospective reporting of stressors is prone to memory distortion and may be linked to certain personality traits (Schroeder & Costa, 1984; Watson & Pennebaker, 1989).

2.3.2 Appraisal processes

It has been considered in the previous section that a set of events or states exist which can be considered as stressors, despite not doing any direct physical damage to the individual. So, given that an event does not signify physical or potential physical threat to an organism, what features make it stressful? One of the earliest classifications was of an event as stressful if it requires significant or major life readjustment and change (Holmes & Masuda, 1974; Holmes & Rahe, 1967; Rahe, 1968). Alternatively, theorists have highlighted undesirability (Suls & Mullen, 1981; Vinokur & Selzer, 1975), loss (Hobfoll, 1989), uncontrollability (Abramson, Seligman, & Teasdale, 1978; Seligman, 1975; Thompson, 1981) and threat to personal identity (Brown & McGill, 1989; Wheaton, 1997) as prime features which make events stressful. It is important to recognise that these are not objective characteristics of an event and, despite consensus decisions which may be made as to relative characteristics of events, each event will have specific meaning to the person experiencing it. This highlights a concept that was not formalised until many years after Selye's original research: That an event or state acquires its stressor status only by virtue of the perceptions of the subject.

Selye's initial work indicated a non-specific response to many stressors with a minimal emotional contribution. This led to a wave of research in which the confounding effect of psychological variables was considered negligible, and where the possibility that Selye's '*first mediator*' which stimulated the alarm reaction might be emotional arousal had not been investigated. However, later research in the 1960s which attempted to minimise the effect of emotional factors and distress in animal

experiments such as Selye's, found that the physiological stress response was reduced (Mason, 1975). For example, Mason found that monkeys who were temporarily deprived of food and able to see other monkeys being fed, exhibited stress symptoms, however those who were fed non-nutritious pellets did not exhibit the same symptoms. This suggested that it was some mental aspect of being starved that led to distress rather than the actual physical effects of malnutrition.

This has led to the development of models of stress containing a form of psychological appraisal. Appraisal represents the personal assessment of the implications and meaning of an event or state and this subjective appraisal determines the magnitude and severity of the stress responses (Lazarus, 1966). Lazarus and Folkman's (1984 p.19) classic definition of when an event is a stressor is '*a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being*'. Thus an event may not objectively pose a threat but may produce a stress response due to its implications as a threat exceeding the organism's ability to cope. The transactional approach highlights that all events trigger an appraisal process and it is only once an event has been appraised as potentially harmful that it can stress an organism.

However researchers have found it difficult to distinguish and separate the two stages of appraisal which may occur almost simultaneously and be inter-dependent. Within Lazarus's model, a resource can only be defined as such when it offsets a demand and vice versa. Coping resources and threat are only definable in terms of each other and this means that the model is difficult to test empirically (Hobfoll, 1989). Other criticisms centre around the conscious, time taking, appraisal process. In emergency situations, appraisal may not have time to occur or the organism may not be able to cognitively process the event and many stressors may not come to conscious attention (Wheaton, 1997).

The transactional model also suggests that people who perceive themselves as able to cope with the stressor are not stressed by this coping process. Hobfoll's (1989) conservation of resources model defines a stressful event as one which has the outcome or threat to diminish existing or potential material, personal, social or environmental resources. Hobfoll's model emphasises loss as an important determinant of stress, thus the event may threaten resources but the coping process may also diminish resources and can produce stress in itself.

Regardless of the exact appraisal formulation which is adopted, it would appear that some form of cognitive perception is essential in the triggering of a stress response by an environmental event. As Lazarus (1991) notes, the announcement of the death of a person would have varying effects on someone who did not understand the announcement, a stranger to the deceased, a friend and a close family member.

2.3.3 Role of personality in appraisal

Personality and disposition can interact with the appraisal process in making it more or less sensitive to the appraisal of events as potential stressors. Those with a greater propensity to appraise environmental events as potential stressors will have a more frequent or severe elicitation of stress responses for a similar environmental load of potentially stressful events and vice versa.

A number of personality features have been identified which might interact with appraisal. The hardy personality delineated by Kobasa (1979) comprises of three facets of: a) commitment - involvement rather than alienation from life; b) challenge - seeing stressors as an opportunity for growth and c) control - perceiving stressors as controllable. Hardiness is proposed to modify the stress-illness relationship in a number of ways, one of which is at the appraisal stage to make potential stressors less threatening (Kobasa, Maddi, & Kahn, 1982; Rhodewalt & Zone, 1989). Dispositional optimism (Chang, 1998; Scheier & Carver, 1985) and high self-esteem (Rector &

Roger, 1996) are other positive personality characteristics which have been linked to improved health.

Personality variables proposed to be linked to more negative appraisals include the related constructs of Type A personality, hostility and cynicism. The type A behaviour pattern was delineated in the 1960s by cardiologists Friedman and Rosenman who noted an association with characteristics of competitiveness, time urgency, hostility and coronary heart disease (Friedman, 1996). Type A behaviour was linked to a doubling of the risk of coronary pathology in large scale prospective studies (Haynes, Feinleib, & Kannel, 1980; Rosenman *et al.*, 1975) and was rated as having a similar impact on coronary risk as traditional risk factors such as hypertension, smoking and cholesterol (Weiss, Cooper, & Detre, 1981). However, when later studies failed to replicate these results (Barefoot *et al.*, 1989a; Shekelle *et al.*, 1985) there was a re-evaluation of which aspect of Type A behaviour was most toxic (Siegman & Dembroski, 1989). One subpart of Type A which has received much attention is hostility (Miller, Smith, Turner, Guijarro, & Hallet, 1996). Hostility is characterised by cynicism, mistrust, sarcasm, overt aggression and frequent and intense anger (Siegman, 1994). Analysis of previous results and new studies have confirmed the importance of hostility as a risk factor for coronary heart disease (Barefoot, Dahlstrom, & Williams, 1983; Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989b; Smith, 1992) and all cause mortality (Barefoot *et al.*, 1983).

One of the ways in which hostility might produce its impact is via increased appraisal of events as stressors, in what is termed a neuroticism confound (Davidson, Prkachin, Lefcourt, & Mills, 1996). Support for this suggestion comes from a study which finds that high hostile individuals do not experience more stressors, but males seem to become more upset when they do experience potential stressors; the same pattern did not hold for females (Davidson *et al.*, 1996).

It is important to realise that all these personality variables might not just be linked to

the appraisal process but may also have their impact at other stages in the stress-illness relationship, such as impact on other stress mediators such as social support, health behaviours, disclosure of emotional distress or by affecting physiological and emotional reactivity to stressors (Friedman, 1996; Funk, 1992; Smith, 1992).

2.3.4 Mental load of stressful thoughts

The above discussion relates to environmental events triggering a stress response depending on their perceived threat value. A second distinction can however be made between stressors which are primarily endogenous. These are the thoughts which run through our minds on a daily basis. The ability of our thoughts to stress us is an extension of the top-down control aspect of the stress response.

As demonstrated by Selye in his experiments (1976), local stressors such as tissue damage induce a systemic stress response. The physical response to exercise can be regarded in a similar manner - producing many of the same physical changes as a psychological stress response - but being determined by local metabolic requirements (Lovallo, 1997). These two 'stress' responses represent bottom-up control processes with physiological adaptations determined by local or metabolic demands.

However, the mental stress response can be activated in anticipation of an actual physical requirement. This facility allows our emotional systems and memory of previous events to enhance our awareness of coming dangers. This can be seen as a evolutionary adaptive facility which enables energy liberating processes to be initiated prior to the metabolic requirements of increased physical activity (Sherwood & Turner, 1992). However, if our perception of the environmental threat is at odds with reality, this means that there may be a needless evocation of a stress response. Or the stress response may be in excess of what is required or may last for longer than is required.

An important aspect of the top-down control facility is that for organisms with the capacity to reflect on events, be sad and anxious, the stress response can be activated by stressful thoughts without the need for external triggers. Again personality variables can interact with this process thus some people may be more likely to become stressed in such an anticipatory fashion.

2.3.5 Conclusion: The definition of stress

The above sections have outlined the stages and mediators leading from perception of environmental events as stressors and from internally generated stressful thoughts, to stress. The term stress is therefore used to describe the mental state produced by an appraised threat or resulting from distressing thoughts. Stress cannot be reduced to an event or state input, as mental processes determine whether this is a threat. Nor can it be reduced to a physiological response, as behavioural and emotional responses occur as well. It cannot be reduced to a transaction between an organism and its external environment, as a second and possibly more important contributor to stress are our own internally generated thoughts.

Within this reasoning, the distinction between acute and chronic stressors is not helpful. Every event stressor might be seen as acute in that it happens once - a death, accident, or news announcement take only a moment. However, there are very few events which provoke only one stress response. A single event of public speaking may be preceded by many experiences of stress and stress responses due to our mental anticipation of the event. It may also produce stress when re-lived. A distinction might be made between major and minor events which are more or less likely to be accompanied by many stress responses. Thus a bereavement may be seen as more severe as it is likely to be preceded and followed by greater intensity stress responses for a longer period of time than having to deal with a flat tyre. Chronic stressors can be seen as a collection of acute events and stressful thoughts connected to the same source. By their continuous nature they may engage greater and longer

duration emotional, behavioural and physiological responses. They may also involve more cognitive processing and thus lead to further stress via ruminative thoughts, as discussed in Section 2.4.2. Therefore in order to understand the effects of stress it is necessary to understand the physiological, emotional and behavioural responses that stress produces - the stress response.

2.4 Facets of the stress response

The experience of stress triggers a set of responses which within this section will be divided into those produced by the hormonal and neural aspects of the response, those occurring from how we feel, and those occurring from what we do. Each of these responses may lead to physical changes which may have health consequences as described in this section.

2.4.1 Physiological response

As noted by Lovallo (1997), the integration of sensory input, emotion and memory in the pre-frontal cortex and limbic system can be seen as the physiological corollary of the appraisal processes proposed by Lazarus and colleagues. If the results of this process are stress, this leads to a set of physiological responses, primarily mediated and co-ordinated via the hypothalamus. The physiological aspects of the stress response can loosely be divided into a neural aspect and an endocrine aspect, as shown in Figure 2.2.

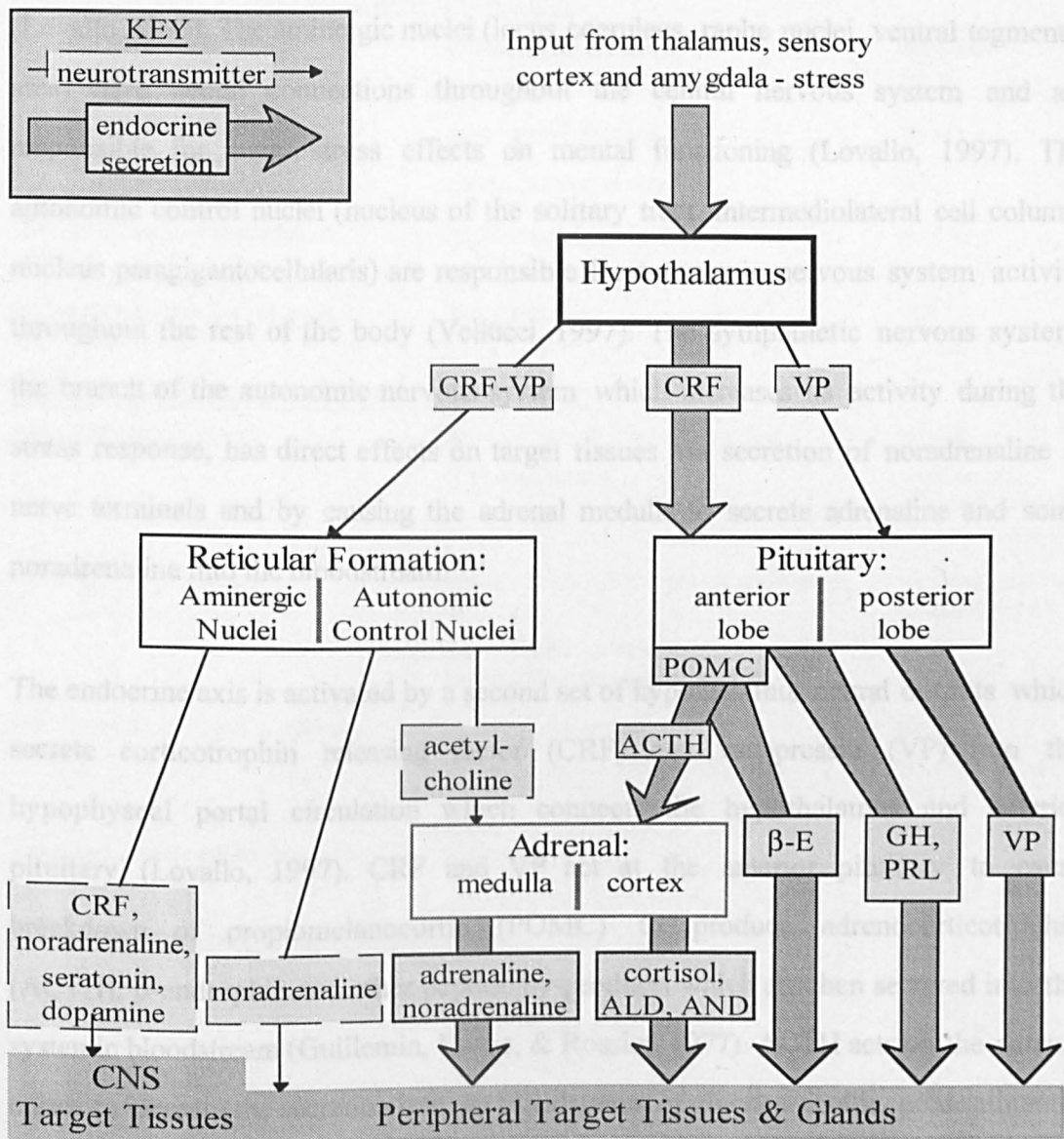


Figure 2.2 Summary of structures, hormones and neurotransmitters involved in the human stress response.

Note. For clarity, specific target tissues are not detailed and only hormones more proximally triggered by stress are shown, see Table 2.1 for details.

Abbreviations: ACTH = adrenocorticotrophin hormone; ALD = aldosterone; AND = androstenedione; β-E = beta-endorphin; CNS = central nervous system; CRF = corticotrophin releasing factor; GH = growth hormone; POMC = propiomelanocortin; PRL = prolactin; VP = vasopressin.

The neural aspect of the stress response produces increased activity in the reticular formation which subsumes the aminergic nuclei and autonomic control centres (Lovallo, 1997). The aminergic nuclei (locus coeruleus, raphe nuclei, ventral tegmental area) have neural connections throughout the central nervous system and are responsible for many stress effects on mental functioning (Lovallo, 1997). The autonomic control nuclei (nucleus of the solitary tract, intermediolateral cell column, nucleus paragigantocellularis) are responsible for autonomic nervous system activity throughout the rest of the body (Vellucci, 1997). The sympathetic nervous system, the branch of the autonomic nervous system which increases its activity during the stress response, has direct effects on target tissues via secretion of noradrenaline at nerve terminals and by causing the adrenal medulla to secrete adrenaline and some noradrenaline into the bloodstream.

The endocrine axis is activated by a second set of hypothalamus neural outputs which secrete corticotrophin releasing factor (CRF) and vasopressin (VP) into the hypophyseal portal circulation which connects the hypothalamus and anterior pituitary (Lovallo, 1997). CRF and VP act at the anterior pituitary to cause breakdown of proopiomelanocortin (POMC) to produce adrenocorticotrophin (ACTH), β -endorphin and other peptide by-products which are then secreted into the systemic bloodstream (Guillemin, Vargo, & Rossier, 1977). ACTH acts on the adrenal cortex to increase the secretion into the bloodstream of glucocorticoids, predominantly hydrocortisone (cortisol) in humans, mineralocorticoids such as aldosterone and androgens, predominantly androstenedione in humans (Sapolsky, 1998). Pituitary secretions of growth hormone (GH), prolactin (PRL) and vasopressin (VP) also acutely increase during stress (Buckingham, Cowell, Gillies, Herbison, & Steel, 1997).

The hormones which are increased during the stress response have widespread effects around the body, as shown in Table 2.1. The short term effects of the stress response act to enhance mental and physical functioning.

Table 2.1 Summary of adaptive actions of acute stress response

Main Outcome: Enhanced mental functioning

<u>Sub-function</u>	<u>Site / process of action</u>	<u>Effectors</u>
Sensory awareness increased	thalamus eyes - pupil dilation	C β_1 -AR
Enhanced cognitive processing	cortex, prefrontal cortex	AN
Enhanced memory formation & retrieval	hippocampus	AN, C
Enhanced emotional awareness	amygdala	AN

Main outcome: Enhanced physical functioning:

Increased cardiac output	heart - \uparrow rate & force contraction \uparrow venous return	β_1 -AR various inc.: \uparrow blood volume* \uparrow blood pressure*
Increased blood pressure	blood vessels - \uparrow peripheral resistance RF - vasomotor centre - baroreceptor regulation inhibited	vasoconstriction & \uparrow haematocrit* CRF
Net diversion of blood supply to muscles	muscles - vasodilation skin & viscera - vasoconstriction	β_2 -AR α_1 -AR, AT, C, VP
Enhanced muscle contractility	skeletal muscles	β_2 -AR

Main outcome: Increased fuel availability:

\uparrow Glycaemia	pancreas - \uparrow glucagon rls. liver - glycogenolysis & gluconeogenesis	C α/β_2 -AR, C, GL
\uparrow Lipidaemia	adipose tissue - lipolysis	β_3 -AR, C, GH
\uparrow Protein catabolism	muscles	C
Prevent re-uptake of fuels by cells	adipose tissue - insulin resistance	C, GH

Main Outcome: Increased oxygen availability

\uparrow Rate & depth breathing	RF - respiratory control centres	CRF
\downarrow Airway resistance	lungs - dilation of bronchioles	β_2 -AR
\uparrow Haematocrit	spleen - contraction	α_1 -AR

Abbreviations. AN = neural input from aminergic nuclei; AR = adrenoreceptor (α_1 , β_1 and β_3 are more sensitive to noradrenaline, whereas α_2 and β_2 are more responsive to adrenaline) AT = angiotensin; C = hydrocortisone; CRF = corticotrophin releasing factor; GH = growth hormone; GL = glucagon; RF = reticular formation; VP = vasopressin; \uparrow = increase; \downarrow = decrease. * = sub-function defined elsewhere.

Table 2.1 Summary of adaptive actions of acute stress response - continued

Main Outcome: Preparation for tissue damage / fatigue:

<u>Sub-function</u>	<u>Site / process of action</u>	<u>Effectors</u>
Fluid conservation (↑ blood volume)	kidneys - ↑ renin-angiotensin cascade adrenal cortex - ↑ ALD rls. pituitary - ↑ VP rls. kidneys - ↑ water retention	β ₁ -AR AT HYPO-VP, AT ALD, C, VP
Enhance blood clotting	platelets	α ₂ -AR
Endogenous analgesia	pituitary - ↑ beta-endorphin rls.	CRF
Enhance immune response	various	PRL, GH
Enhance inflammatory response	various	PRL, GH
Fever	hypothalamus - ↑ temperature set-point	CRF

Main Outcome: Conservation of resources:

Suppress digestive activity	glands- ↓ digestive secretions intestines - ↓ motility	α ₁ -AR, GHIH β ₂ -AR
Suppress reproductive activity	hypothalamus - ↓ GnRH rls. pituitary - ↓ LH, FSH rls. target tissues - ↓ sensitivity	β-E, CRF, C PRL, C C
Suppress growth	hypothalamus - ↑ GHIH rls. pituitary - ↓ GH rls. pituitary - ↓ TSH rls. target tissues - ↓ sensitivity GH & TSH	CRF, C GHIH, C GHIH, C C
↓ Hunger and libido	hypothalamus	CRF

Abbreviations. ALD = aldosterone; AR = adrenoreceptor; AT = angiotensin; β-E = beta-endorphin; C = hydrocortisone; CRF = corticotrophin releasing factor; FSH = follicle stimulating hormone; GH = growth hormone; GHIH = growth hormone inhibiting hormone; GnRH = gonadotrophic releasing hormone; HYPO-VP = neural input from hypothalamus; LH = luteinising hormone; PRL = prolactin; rls. = release; TSH = thyroid stimulating hormone; VP= vasopressin; ↑ = increase; ↓ = decrease.

This table summarises information from Marieb (1998), Lovallo (1997), Chrousos and Gold (1992) and Vellucci (1997).

Breathing is enhanced and fuel stores are catabolised to increase availability of fuels and provide more oxygen in the blood. Cardiac output increases and changes in blood vessel diameter route proportionally more blood to working muscles. Thus delivery of these fuels and oxygen to the muscles and removal of metabolic waste products from muscles occurs more efficiently. These and other changes enhance muscle functioning to enable the body to expend physical energy to either fight or flee the cause of the stress. To prevent diversion of resources to any functions not immediately essential, growth, reproductive and digestive processes are halted. Other changes can be seen as enhancing the ability of the organism to function as effectively as possible in the face of injury or fatigue. Thus there is short term up-regulation of the immune system competence, an enhanced inflammatory response, endogenous analgesics are produced and fluid conservation processes guard against loss of blood from haemorrhage. .

The short term effects of the stress response are exquisitely engineered to facilitate coping with a stressor that requires muscular action. However, some stress response effects which are useful in short term emergency situations can become pathogenic if allowed to persist (Munck, Guyre, & Holbrook, 1984).

For example, the stress response produces an increased work rate and thus increased oxygen requirements of heart muscle. If the coronary arteries are not able to supply enough oxygenated blood, parts of the heart muscle become ischaemic. Ischaemic heart tissue, does not conduct the electrical impulse of the heart beat in the same manner as normal tissue, and this may cause life-threatening arrhythmias which can lead to cardiac arrest (Smith & Leon, 1992). Additionally, if unresolved, ischaemia can lead to a myocardial infarction which depending on its severity may prevent the heart from pumping properly.

Mechanical trauma from increased blood pressure during stress and the toxicity of glucocorticoids and catecholamines has been linked to injury of the arteries with the subsequent initiation of atherosclerosis development (Krantz & Manuck, 1984). Fatty

acids released into the blood during stress may accumulate in plaques accelerating their development (Ross, 1993). Finally, the stress induced increases in blood clotting ability can promote the development of clots on the plaque surface (Kamarck & Jennings, 1991). Mechanical trauma is also a risk factor which can initiate the sequence whereby material from existing atherosclerotic plaques can lodge in other vessels, compromising the blood supply and causing ischaemia and its sequelae (Sary *et al.*, 1995).

Thus the transient increased work load of the heart involved in the stress response may lead to damage. The short term effects of the stress response on the heart can be seen in the higher than average rates of sudden cardiac death which follow reports of psychological stressors (Kamarck & Jennings, 1991). Higher than normal rates of heart attack and other coronary events are seen in populations affected by large scale stressors such as earthquakes (Leor, Poole, & Kloner, 1996) or missile attacks (Kark, Goldman, & Epstein, 1995) and even an objectively rated less severe stressor, that of an encounter with doctors during a ward round, has been linked to increased rates of myocardial infarction (Jarvinen, 1955).

Although not fully understood, the heightened activity of the immune system has been implicated in the development of various autoimmune system disorders (Munck *et al.*, 1984). Metabolic changes, which during the stress response prevent cells storing glucose when it might be more profitably used by muscles, may accelerate the development of Type II diabetes whereby cells become permanently resistant to the effects of insulin and unable to store glucose normally (Sapolsky, 1998). Over-perfusion of tissues with oxygenated blood, which occurs where the stress response is in excess of metabolic demands, has been thought to trigger autoregulatory mechanisms which may lead to hypertension in the absence of the stressors (Obrist, 1981). Additionally it has been suggested that transient increases in blood pressure can lead to structural changes in the coronary arteries which once present enhance cardiovascular reactivity and subsequent development of hypertension (Folkow,

1990). Ulcers were one of the key signs of stress noted by Selye (1976) and although the exact mechanisms underlying their development are not known (Levenstein, 1998), fluctuations in digestive system activity which occur with the stress response may be part of the trigger (Sapolsky, 1998).

Given that the body's heightened level of activity during the stress response can be pathological, mechanisms exist to return the body to rest levels of functioning at the end of a stressor. Primary amongst these mechanisms are those co-ordinated by glucocorticoids, i.e. hydrocortisone in humans. Glucocorticoids suppress the inflammatory response, down-regulate the immune system, and assist in fluid balance (Munck *et al.*, 1984). Hydrocortisone also suppresses the secretion of many of the 'stress hormones'. Hydrocortisone levels take approximately 30 minutes to peak after the onset of a stressor, this means that the suppressive effects are delayed to allow the defence reactions to serve their purpose (Herbert & Cohen, 1993). In order to prevent the 'over-suppression', glucocorticoids provide strong negative feedback on their own secretion (Checkley, 1996).

Thus the adaptive stress response can be seen as having three stages; a) an initial state of heightened activity which provides energy to neutralise the threat perceived by the organism, b) a suppression of these defence reactions by hydrocortisone and c) a suppression of the suppression via negative feedback from hydrocortisone levels. This process is ideally suited to provide short bursts of energy to enable an organism to deal with a physical threat for a short period of time e.g. half an hour.

At this point, two aspects which lead to the toxicity of the stress response to humans can be highlighted. Firstly, the types of stressors which humans regularly face are not of the type which are neutralised by a burst of physical energy over a short time period. Rather the stressors faced by modern humans often do not require or at least are not generally met with physical solutions. Therefore the physiological stress response, which is suited to mobilising physical energy reserves, may be in excess of

demands and thus the effects of heightened oxygen levels in the absence of muscular activity, excessive levels of metabolites and the increased work load of the heart in the absence of requirements can cause damage. The type of stressor faced by humans is also not necessarily easily able to be neutralised and therefore, the brain may persist in sending messages of stress to sustain the stress response.

Secondly, as humans are able to trigger the stress response by thinking about stressful things. It means that the stress response may be triggered after the stressor has been neutralised, independently of the stressor, or in advance of the stressor. Although, as mentioned, increases in hydrocortisone levels usually inhibit their own further production, if neural signals persist, over-ride of the glucocorticoid negative feedback can occur (Checkley, 1996). This allows a chronic high level of glucocorticoid secretion to become established and this underlies many of the pathological aspects of the stress response. Perversely, chronic high levels of glucocorticoids have been linked to brain damage to the hippocampus which may further weaken the ability to fine tune glucocorticoid levels (Sapolsky, 1996).

Chronic high levels of glucocorticoids may down-regulate the immune system and inflammatory response to such an extent that they are unable to perform their roles adequately. Herbert and Cohen (1993) determined in a meta-analysis of 38 studies on experimental, acute and chronic stressors that there were consistent decreases in proliferative responses of lymphocytes to mitogens and in natural killer cell activity. Kelly *et al.* (1997) concur with this finding in their narrative review, finding that lymphocyte proliferation levels are consistently depressed in people experiencing chronic stressors.

The immune system is important not just to ward off infection but also to remove tumour cells. A robust finding which has been noted in many narrative reviews of psychoneuroimmunology is that stressors are linked to increased rate of upper respiratory infections, tuberculosis and activation of latent viral infections (Biondi &

Zannino, 1997; Cohen & Herbert, 1996; Cohen & Williamson, 1991; Jemmott & Locke, 1984; O'Leary, 1990). For example, studies at the Common Cold Research Unit have linked participants ratings of recent life stress to their risk of infection by a standard exposure to common cold virus (Cohen, Tyrrell, & Smith, 1991).

Whether stress can lead to cancer is less well established. Not all researchers accept a stress-cancer link and suggest that over-reliance on animal, in vitro and retrospective studies may account for these findings (Sapolsky, 1998). The largest sample size and studies with best design show no greater risk (Petticrew, Fraser, & Regan, 1999). Psychosocial stress may however be linked to cancer progression (Cohen & Herbert, 1996; Sapolsky, 1998).

The inflammation response is important in facilitating healing. Consistent with suppression of the inflammatory response by stress, Kiecolt-Glaser and colleagues (1995; 1998) have found delayed wound healing in dental students undergoing exams, Alzheimer's caregivers and mice after restraint stressor. Healing of standardised wounds was slower by 24%-40% in these populations (Kiecolt-Glaser *et al.*, 1998). Sustained chronic stress has also been implicated in development of irritable bowel disorders such as Crohn's disease and ulcerative colitis (Drossman, 1998).

2.4.2 Emotional response

The emotional response to a stressor can range from anger, despair, frustration and anxiety. The emotional response to a stressor is predominantly mediated by the amygdala which has connections to the hypothalamus and reticular formation.

Research by Henry (1986) has distinguished two reactions to a stressor, '*defence*' where the animal is alerted to danger and actively struggles for control of the situation and '*defeat*' where the animal appears to have given up on a struggle. These two reactions are also accompanied by differential physiological responses. Whereas the

defence reaction involves greater reaction of the 'neural' axis with increases in blood catecholamine levels and concomitant physiological changes such as increased heart rate and increased blood pressure, the defeat reaction is accompanied by increases in ACTH and glucocorticoid secretion. Thus it is likely that stressors which induce feelings of lack of control or despair are accompanied by relatively larger increases of glucocorticoids than stressors promoting challenge. This may have implications for health vis-à-vis the differential effects of excess glucocorticoids and cardiovascular response.

The emotional response of anger to a stressor may also have health implications. Anger has been related to increased incidence of coronary problems (Smith, 1992; Williams, Barefoot, & Shekelle, 1985). People who react to stressors with what are termed non-effective anger management styles of either bottling up and suppressing angry thoughts or in contrast vigorous expressions of anger are more prone to a constellation of health problems (Thomas, 1997). Researchers have found that the relative risk of having a myocardial infarction doubles in the two hours after being angry (Mittleman *et al.*, 1995). Anger discussion, in contrast, is a management style related to better health (Thomas & Williams, 1991).

One important contribution to the mental stress load is the baggage carried from previous stress experiences. Ruminations are defined as intrusive thoughts about past events which are neither pleasant nor useful (Gold & Wegner, 1995). They have a pointless quality in that they are unable to change the circumstances of the past event (Gold & Wegner, 1995). Rector and Roger have found that low self-esteem is related to tendency to ruminate (1996). Rumination may lead to sustained physiological and psychological activation and therefore this may result in excess levels of stress hormones (Cameron & Meichenbaum, 1982; Roger & Hudson, 1995; Roger & Jamieson, 1988).

2.4.3 Behavioural response

The behavioural response can be seen as efforts to cope with the demands of the stressor. Coping may be successful and neutralise the threat of a stressor, or if ineffective may lead to a continuation of the stressor or generate further stressors.

One aspect of coping which is particularly relevant to health is the decrease in self care behaviours and an increase in risk behaviours which may occur (Mechanic, 1976; Steptoe, 1991). Increased risk behaviours may result from; a) lack of time due to pressure of the stressor / coping e.g. poor dietary habits, b) a desire to escape the stressor e.g. drug consumption, and c) the cognitive load or worry e.g. sleep disturbance. Studies have documented riskier smoking behaviour, exercise, eating habits, alcohol consumption and drug abuse in people reporting high stress levels (Ogden & Mtandabari, 1997; Steptoe, Wardle, Pollard, Cannan, & Davies, 1996). These can lead to illness directly through increasing risk of accidents or via changes in physical systems which may make us more vulnerable to illness. Poor sleep patterns, poor diet, consumption of caffeine, alcohol and a number of drugs can have immunosuppressive effects (Herbert & Cohen, 1993; Kaplan, 1991) and cigarette smoking, physical inactivity, and obesity are recognised risk factors for coronary heart disease (American Heart Association, 1998; Ross, 1993). Cohen and Williamson (1991) note that efforts to seek out information and support from other people may bring one into contact with a larger number of pathogens. Therefore behavioural aspects of the stress response may have an impact on disease susceptibility.

Even if people do not actually become ill when stressed, they may feel it. Illness behaviour is in part determined by recognition of physical sensations, labelling of sensations as symptoms, labelling of symptoms as disease and seeking medical attention. Within this process, stress may increase physical symptoms due to the physiological changes provoked, and increase the likelihood that these sensations and symptoms are considered indicative of disease (Cohen & Williamson, 1991; Mechanic, 1976). Seeking medical attention may be both increased and decreased under stress and

this behavioural action may lead to either increased usage of health services in the absence of pathology or a delay which results in more serious later problems.

2.4.4 Summary: the stress - disease link

The acute physiological stress response is an adaptive response to potential or actual increased energy requirements. However, the repeated disruption of normal restful functioning may lead to digestive system disorders. The levels of fuels and oxygen in excess of metabolic demands may lead to insulin resistance, hypertension and accelerate the process of atherosclerosis. High work requirements of the heart can damage pre-existing plaques and increase the oxygen requirements of the myocardium both of which contribute to risk of ischaemia and related pathologies. Chronic high levels of hydrocortisone which may result from sustained stress responses can down-regulate the immune system and inflammatory response to the extent that they are unable to function adequately resulting in delayed healing and increased susceptibility to infection.

The emotional and behavioural aspects of the stress response may exacerbate the immediate intensity and duration of the stress response and via rumination lead to repeated stress responses in the absence of potent external triggers. Behavioural aspects of the stress response such as a decrease in self care behaviours and increase in risk behaviours may lead to ill health directly via accidents and injury or indirectly by causing physiological changes which increase susceptibility to other illnesses and conditions. Effectiveness of coping may determine the duration and impact of environmental stressors. Adoption of a sick role may lead to illness behaviour in the absence of pathology.

There are thus many routes by which the stress response may lead to illness. However, stress does not always lead to illness and some people seem to be more susceptible than others. An enduring issue in health psychology is the examination of

what factors are important in differential susceptibility to stress (Adler & Matthews, 1994). At the stage that the links between stress reactivity and ill health were first being proposed, it was not feasible to monitor people's responses to stressors existing in their daily life. Therefore, one way in which researchers have tackled this question, has been to try to recreate the features of a physiological stress response in a laboratory.

2.5 Reactivity research

Historically stress reactivity research has concentrated on monitoring reactivity of the cardiovascular system. This is due in part to the ease with which changes in cardiovascular activity can be observed: The measurement of blood pressure and heart rate can both be accomplished using non-invasive techniques. In contrast, the sampling and measurement of hormonal or immune indices of the stress response may be stressful for participants and thus cause changes in the parameters under study. Additionally, at the time that reactivity research was developing, understanding and ability to assay the hormonal and immunological components of the stress response was also far less developed.

A further reason for studying cardiovascular reactivity comes from its proposed direct link to the development of hypertension and coronary heart disease, respectively the most prevalent cause of ill health in the world (World Health Organization, 1997) and leading cause of death in industrialised countries (Office for National Statistics, 1998; World Health Organization, 1997).

2.5.1 How has stress been modelled in the laboratory?

One of the first laboratory based procedures used to elicit a stress response in humans was the cold pressor test developed by Hines and Brown (1936). The cold pressor

test involves placing one's hand in iced water for a period of one minute. Blood pressure measurements taken at 30 and 60 seconds into the task provide a measure of the task level of blood pressure. This can then be subtracted from a previous estimation of basal levels to give a measure of reactivity.

Hines and Brown's research established that even though the stimulus can be held relatively constant, large individual differences exist in the magnitude of blood pressure increases. Hines and Brown proposed that people with higher reactivity would be at greater risk of developing hypertension in later life. They supported this hypothesis with evidence that in their sample, those with higher reactivity were more likely to have a family history of hypertension - a risk factor for development of hypertension. Furthermore, they implicated excessive reactivity as a causal factor.

Current reactivity research uses many different types of task to activate the stress response (Turner, 1994). These range from stressors which require participants to make active attempts to cope such as mental arithmetic, giving a speech or playing computer games, to stressors which the participant passively endures such as watching films or the cold pressor test (Obrist, 1981).

2.5.2 Links between laboratory stressors and daily life stressors

Given that the tasks used in the laboratory are not similar to either the events or states conventionally included in life events or minor hassles inventories, it is important to establish how these reactions relate to those seen during real life stresses.

There are two theories as to how reactivity modelled in the laboratory relates to daily levels (Manuck & Krantz, 1986). First, the *recurrent activation model* suggests that responses measured in the laboratory resemble repeated responses seen in daily life. Thus a person who reacts strongly to a laboratory task will have larger transient episodes of reactivity during daily life, whereas a person who reacts weakly to a

laboratory task will have more modest increases in response to daily stressors. A second model, the *prevailing state model*, proposes that the level of response seen in the laboratory can in some manner be correlated to the general levels seen throughout the time period when the individual is actively engaged for example during working hours. Both of these theories suggest that the value of measuring cardiovascular reactivity in the laboratory is due to it being a stable psychophysiological trait which can be related to the fluctuations seen in daily life. This would enable pathogenic effects to develop over a lifetime. Critical to this argument is whether cardiovascular reactivity measured in a laboratory is a stable personal characteristic which can be reproduced on separate time occasions.

A number of estimates have been made of the test-retest reliability of laboratory based measures of blood pressure and heart rate reactivity. In a comprehensive review of a large number of studies, with varying test-retest intervals, Steptoe (1990) found significant test-retest correlations for heart rate in 30/36 assessments, for systolic reactivity in 26/30 comparisons, but in only 18/30 comparisons for diastolic blood pressure. A meta-analysis is not strictly suitable for these comparisons as there is a wide variation in test-retest interval. However, it seems that test-retest reliabilities for cardiovascular reactivity can be compared to those found for other psychological tests and can be considered to represent a fairly stable individual characteristic. For comparison, the long term stability of well-established psychological measures such as positive affect $r=.42$, and negative affect $r=.43$ are of a similar low but significant level (Watson & Walker, 1996).

A more recent meta-analysis by Swain and Suls (1996) concluded that overall, the mean test-retest correlations were heart rate $r=.55$, systolic blood pressure $r=.41$ and diastolic blood pressure $r=.35$. Swain and Suls indicate that this puts the stability of heart rate and systolic blood pressure reactivity as strongly reproducible and diastolic blood pressure at the high end of moderate reproducibility. This seems to confirm the trends found by Steptoe (1990) in that the stability of heart rate and systolic blood

pressure is higher than diastolic blood pressure. It is not known how closely these figures represent limits of methodology or actual limits to the reproducibility of cardiovascular reactivity.

2.5.3 Mechanisms linking cardiovascular reactivity to ill health

The cardiovascular reactivity hypothesis suggests that those who react more strongly to stressors have an increased risk of developing cardiovascular disorders such as hypertension or coronary heart disease (Krantz & Manuck, 1984). Although this suggestion has face validity from the increased work load that the stress response puts on the heart, reactivity research in the laboratory augments this in three main ways.

First reactivity research has confirmed the findings of Hines and Brown (1936) that groups at greater risk of developing hypertension and coronary heart disease have higher reactivity. Cross-sectional studies have found higher reactivity in children of hypertensive parents (Fredrikson & Matthews, 1990; Matthews & Rakaczky, 1986; Saab & Schneiderman, 1995), people with borderline hypertension (Fredrikson & Matthews, 1990) and those who have Type A personality pattern (Corse, Manuck, Cantwell, Giordani, & Matthews, 1982; Matthews, 1982; Rosenman & Friedman, 1974) - all groups expected to be at greater risk of developing either hypertension or coronary heart disease..

Second, research has examined whether people who evidence higher reactivity are at greater risk to develop either hypertension or coronary heart disease in the future. The results of research in this area have been mainly negative (Pickering & Gerin, 1990). Notable exceptions are the study of Wood (1984) with a 45 year follow-up which found reactivity to a cold pressor test predictive of later development of hypertension and that of Keys and Taylor (1971) which found diastolic reactivity to a cold pressor test was significantly related to development of coronary heart disease after 23 year follow-up. Given its early development, the cold pressor test has been the basis for

the majority of long term follow-up studies. However, on the basis of continuing negative associations, a number of researchers are questioning its value. The cold pressor test was shown to be least predictive of differences in reactivity of at risk groups (Fredrikson & Matthews, 1990), suggesting that reactivity to this test might not be closely related to risk of cardiovascular damage.

Other types of test have been seen as more productive. Sallis, *et al.* (1991) found that exercise reactivity was linked to changes in blood systolic blood pressure in adults followed-up for 2 years. Matthews, Woodall and Allen (1993) also found associations between reactivity to various tasks and resting blood pressure at 6.5 year follow-up in middle aged parents and their children. A longer study over 10 to 15 years found a significant association between reaction time task blood pressure reactivity and follow-up resting levels (Light, Dolan, Davis, & Sherwood, 1992). Although it might not be expected that blood pressure in children would change much from year to year, Murphy, Alpert, Walker and Willey (1991) found correlations between diastolic reactivity to a video game task and follow-up resting blood pressure one year later independently of the resting blood pressure. Carroll, Smith, Sheffield, Shipley and Marmot, (1995) found a significant relationship between reactivity to a psychological stress test and resting systolic blood pressure after a 4.9 year follow-up, once baseline levels had been controlled in the analysis. Although the authors note that prior resting levels were much more strongly related to follow-up resting levels than prior reactivity.

Although current evidence is somewhat equivocal, it is hoped that as the results of studies using stressors other than the cold pressor test become available with longer follow-ups that a clearer picture will emerge linking reactivity to future development of hypertension and cardiovascular disease (Blascovich & Katkin, 1995). However, even if cardiovascular reactivity was linked to later development of cardiovascular outcomes, this would not identify whether it is a marker or a causal element in the process (Rosenman, 1996; Rosenman & Ward, 1988).

The third branch of evidence which relates cardiovascular reactivity to health problems comes from animal studies. Animal studies by virtue of the control which can be gained over the environment of the animals and the ability to perform more invasive techniques not ethical on human participants have been able to provide supportive evidence for the link between stress and disease (Kaplan, Manuck, Williams, & Strawn, 1995). Kaplan and colleagues established that monkeys kept in unstable social conditions developed higher levels of atherosclerosis (Kaplan, Manuck, Clarkson, Lusso Taub & Miller, 1983) and that the monkeys who evidenced the greatest increases in heart rate had higher levels of atherosclerosis (Manuck, Kaplan, & Clarkson, 1983). Kaplan, Manuck, Adams, Weingand, and Clarkson (1987) found that drugs which block the activity of the sympathetic nervous system and thus moderate the cardiovascular reactivity, ameliorate the effects of extreme stressors on atherosclerosis in dominant monkeys and Strawn *et al.* (1991) found similar ameliorating effects of beta-blockers on injury in arteries of all monkeys. These results heavily implicate both disruptive social environment and high stress reactivity in the pathology of atherosclerosis and intimal injury.

Complementary results have been found in humans. A study by Kamarck *et al.* (1997) of middle aged male participants found those with greatest blood pressure reactions to a series of mental tasks had thicker layers of the intima in carotid arteries assessed by ultrasound testing. The thickness of carotid artery intima is taken to be associated with greater levels of atherosclerosis in all blood vessels including coronary ones. Matthews *et al.* (1998) report similar results with women - those with greater pulse pressure increases (difference between SBP and DBP) had more developed carotid artery atherosclerosis. Kral and colleagues (1997) found that people who had silent (painless) myocardial ischaemias during exercise testing also had higher reactivity to mental stress testing. In fact those with exercise induced ischaemia were 21 times more likely to be in the top quartile of reactors.

2.5.4 The value of cardiovascular reactivity research

Study of cardiovascular reactivity within the laboratory has helped to sharpen the stress and disease causal link by providing supportive evidence that some groups of people with higher reactivity are also at more risk of cardiovascular pathologies and in suggesting direct pathological mechanisms which have been tested in laboratory animal studies. What they do not do is allow the classification of an absolute level of reactivity which is seen as pathological. Therefore risk must be defined in relative terms. Given that cardiovascular reactivity is a causal factor in cardiovascular pathology, it allows examination of conditions which might moderate this process.

Chapter Three

Human social relationships as modifiers of the stress-illness relationship

3.1 Introduction

The link between human relationships and human health has justifiably received more attention than any potential link between human-animal relationships and human health. Collis & McNicholas (1998) argue that it is implausible that humans have evolved special mechanisms to deal with their relationships with non-human species. It seems more likely that humans will draw on mechanisms used in human-human relationships in relating to animals. Therefore, mechanisms which relate human relationships to health may be applicable to any link between human-animal relationships and human health. The aim of this chapter is to review studies which demonstrate a link between human relationships and to consider the mechanisms which might underlie this link. In particular, attention will be given to the recent suggestion that human relationships may moderate the physiological response to stress. As discussed in Chapter 2, extreme physiological response to stress has been linked to future cardiovascular pathology and thus a moderation of this response might be beneficial.

3.2 Human relationships and human health

The origin of concerted interest in the impact of human relationships on human health can be traced back to the publication of two review papers in the 1970s (Cassel, 1976; Cobb, 1976). These papers drew together experimental evidence from studies on humans and on other animals which suggested that social relationships influenced

health. Although, as noted by Cassel (1976), none of the individual studies were strong enough to unambiguously establish the connection between social relationships and health status, when presented collectively the studies made a strong case that there was some type of link. Both authors used the term *social support* to describe the health beneficial aspects of social relationships which modify the impact of stress. There is now general acceptance of a multi-dimensional construct of social support. The components differ slightly between models, but most include elements such as emotional support, esteem support, instrumental support etc.

These two review papers were swiftly followed by a number of studies which linked the presence of higher numbers of social relationships with better human health. These studies took into account the number of people with whom the respondent is in close contact, frequency of contact, strength of ties, social participation and social anchorage (Gottlieb, 1981). However, cross-sectional studies which examine whether people in better health have larger social networks are unable to determine whether the link might be due to a decline in social relationships in those with poorer health (House *et al.*, 1988a). To counteract this problem, evidence is required from large scale prospective studies which can link the presence of social contacts to mortality and morbidity incidence over a follow-up period.

The classic Alameda County study (Berkman & Syme, 1979) serves as an example of this type of prospective study. It examined four measures of social ties, representing supposedly different degrees of closeness of relationship: a) marital status, b) contact with friends and relatives (number of people in category and frequency of contact), c) membership of religious group and d) membership of other formal or informal groups. Generally, people who reported more ties at each level had lower mortality levels at a nine year follow-up. Additionally, a composite social index score weighted for the closeness level of reported contacts was used to differentiate respondents with differing levels of social integration. Those more integrated had lower mortality risk than those less well integrated people. Importantly, Berkman and Syme examined

several alternative explanations such as the possibility that those with worse health are less able to maintain social ties, and other factors associated with mortality risk which might also be associated with the social network index, e.g. self-reported health, socioeconomic status, health practices and utilisation of health services. None of the alternative explanations was able to reduce the strong association between level of social ties and mortality. More recent studies have confirmed the findings of the Alameda study that those with larger social networks have better health (House *et al.*, 1988a).

Although the earliest social network studies examined mortality from all causes, later studies and re-analyses have examined whether there are differential health advantages for specific illness. For the leading cause of death, circulatory diseases, a number of studies have provided evidence that social support is linked to a reduction in mortality from coronary heart disease (Berkman & Syme, 1979; House, Robbins, & Metzner, 1982; Kaplan *et al.*, 1988; Orth-Gomér & Johnson, 1987; Orth-Gomér, Rosengren, & Wilhelmsen, 1993). For example, Orth-Gomér, Rosengren and Wilhelmsen found that a measure of social support based on composite measures of numbers of people of varying closeness encountered in daily life, and availability of support from those people, predicted the rate of deaths due to coronary heart disease in 50 year old men followed for six years. Studies focusing on effects of social integration on incidence of coronary heart disease have also found positive effects (Orth-Gomér *et al.*, 1993; Reed, McGee, Yano, & Feinleib, 1983; Vogt, Mullooly, Ernst, Pope, & Hollis, 1992). For example, social network size was inversely associated with incidence of MI, angina and coronary heart disease for men with Japanese ancestry living in Hawaii (Reed *et al.*, 1983). Social integration has also been found to increase survival after MI (Ruberman, Weinblatt, Goldberg, & Chaudhary, 1984). Overall, social integration, as measured by social network indices seems to have an impact on incidence, mortality, recovery and survival related to circulatory system disease (Cohen, Kaplan, & Manuck, 1994; Greenwood, Muir, Packham, & Madeley, 1996; Orth-Gomér, 1994).

For less predominant causes of death, evidence from prospective studies is limited by the smaller numbers of people dying from each pathology. Therefore, confidence in findings may be limited by the low power of such analyses. Social integration (diversity, size or frequency of contact) was not found to have any impact on incidence of hypertension, cancer or stroke in the Northwest Kaiser Permanente study (Vogt *et al.*, 1992). However a weak relationship was found with survivorship after cancer or stroke and social network scope (a measure of the diversity of a social network) (Vogt *et al.*, 1992). Social network size has been linked to propensity to catch colds in a controlled exposure study (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997).

Social network studies establish that the nature of social relationships is associated with health. However they do not establish the potential mechanisms which may underlie this association. The assessment of presence or absence of social relationships represents a structural approach to assessment of social support. It relies on presumption that more relationships will lead to higher levels of whatever the supportive provisions of relationships are. There is some evidence to support this intuitively plausible presumption. Seeman and Berkman (1988) found that in an elderly sample, size of social network was positively related to reported levels of instrumental and emotional support. However, the correlations were not so high as to make the measures interchangeable and perceived adequacy of support was not related to the size of network.

One reason for this lack of correspondence between the two measures is that high levels of support may be provided by a few quality relationships. This is consistent with Weiss's (1974) model of the provisions of social relationships. The social network studies, although examining quantity of relationships and not their quality, do provide evidence suggesting that the nature of the relationship is important, as relationship types which might be presumed to be of greater depth and intensity have greater effects on health (e.g. Berkman & Syme, 1979). However, a more in depth

study of the functional aspects of social relationships would require measurement of pertinent aspects of relationships, such as the level of different elements of support from particular relationships.

There are two models of how social relationships might produce health advantages. First, there are mechanisms which might be expected to operate at all times thus leading to a generalised benefit to health, this is termed the main effect. Second, there are mechanisms which are particularly pertinent to stressful situations. These might be general mechanisms which operate more intensely during stressful times or specific mechanisms related to stress buffering. This leads to two models of the moderating effects of social relationships on health, see Figure 3.1. Under the main effects model, there should be a general advantage to those with higher levels of social support / social provisions. Health problems are expected to be greater at high levels of stress, but the difference in health between situations of high and low stress should be the same whether there are high or low levels of social support. Under the buffering model, people with high levels of social support might expect that their health status would not change as much at higher levels of stress. People low in support would expect a larger increase in symptoms at higher levels of stress.

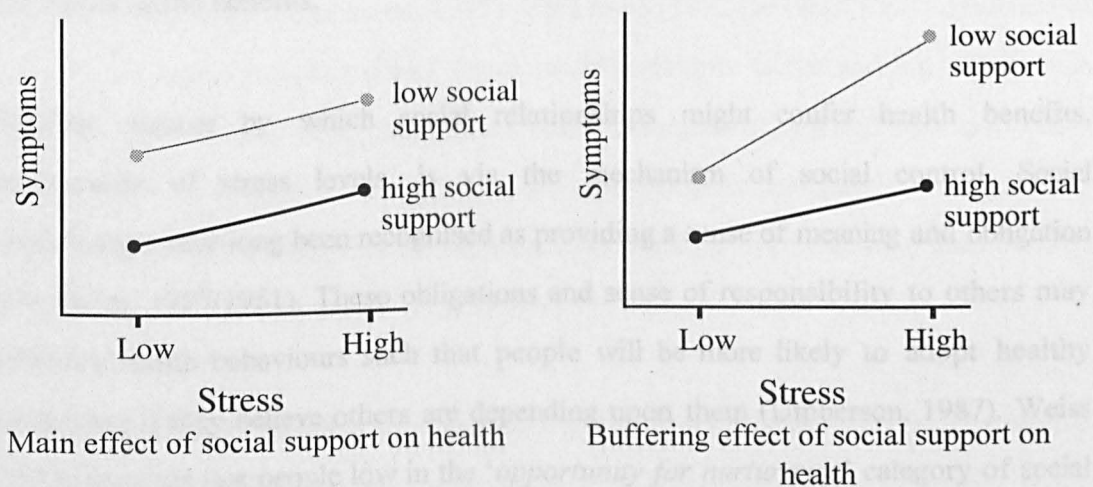


Figure 3.1 Examples of buffering and main effects models. Adapted from Cohen & Wills (1985).

Much research and analysis has been undertaken to decide which of the mechanisms might be operating. However the design of many studies has limited their ability to detect buffering effects. The two models cannot be distinguished if stress levels were not examined (Cohen & Wills, 1985; House, Umberson, & Landis, 1988b). Nonetheless, the models have implicitly or explicitly influenced models of the functions of social relationships in that some are described as having stress buffering effects whereas others are for general well-being.

3.2.1 Stress independent effects of social relationships on well being

The threshold model posits that people have a need for a supportive environment and if this drops below a threshold level, then they become vulnerable to disease (Lynch, 1977). Lack of social integration or loneliness can be seen as a stressor in itself.

Cohen and Wills (1985) suggest that the threshold level at which lack of social contact can become a stressor is quite low, as effects on well-being occur mainly for the distinction between social isolates and those with moderate and high levels of social contacts. The implication of this is that, for people who already reach a minimum level of social support, an increase in levels of social support would not provide any additional health benefits.

Another manner by which social relationships might confer health benefits, independent of stress levels, is via the mechanism of social control. Social relationships have long been recognised as providing a sense of meaning and obligation (Durkheim, 1897/1951). These obligations and sense of responsibility to others may influence health behaviours such that people will be more likely to adopt healthy behaviours if they believe others are depending upon them (Umberson, 1987). Weiss (1974) cautions that people low in the '*opportunity for nurturance*' category of social provisions '*may be tempted to let themselves go*' when encountering stress.

Social control is a term used by sociologists to represent the regulatory aspects of social relationships (Meier, 1982). Parsons (1951) notes two ways by which social control affects behaviour indirectly via internal influence or directly via external influence. Social relationships may indirectly promote healthful behaviour due to perceived responsibilities, by providing an environment conducive to health behaviours or a role model (Umberson, 1987). Direct control of behaviour may occur due to 'nagging' or other verbal cues to behaviour, physical intervention or sanctions against undesired behaviours, (Umberson, 1987). People who engage in fewer health behaviours and more health risk behaviours have a higher mortality (Belloc, 1973) and morbidity (Belloc & Breslow, 1972). Therefore, social relationships might have a beneficial impact on health through promoting health behaviours and decreasing risk behaviours. There is evidence to support this contention from studies of relationships which provide a sense of responsibility.

Specific relationships which provide a sense of responsibility such as marriage and parenting have been strongly associated with lower mortality and morbidity (Kobrin & Hendershot, 1977; Moriyama, Krueger, & Stamler, 1971). In a comparative study, Umberson (1987) found that married people and those with children in the home engage in least unhealthy behaviour. Conversely, divorced people engage in most unhealthy behaviours (Umberson, 1987). Umberson (1992) has also found evidence to support the contention that direct social control attempts occur and are effective in promoting health behaviour change, especially amongst the married and men. This may explain the gender and marital status differences in mortality and morbidity which consistently favour men as deriving more benefits from marriage than women (e.g. Lynch, 1977; Moriyama *et al.*, 1971).

Companionship, i.e. spending time in leisure pursuits with others may be pleasurable but whether it can be considered a component of social support is debatable. Rook (1990) separates companionship from social support on two grounds. First, companionship is engaged in not for the potential problem-solving dividends, but

purely for the goal of enjoyment. Second, she suggests the effects on health of companionship will differ from those of social support. Companionship would be expected to have a main effect on health rather than a stress buffering role. Social support will be of benefit in times of stress to restore functioning to previous equilibrium when decreased by the experience of stress. Companionship, in contrast would be expected to have beneficial effects even for persons who are not experiencing stressful events and to encourage positive psychological well-being which can result in an increased level of contentment above baseline levels (Rook, 1987).

Although Rook suggests that companionship may be engaged in for its own benefits rather than specifically for stress moderation, her predictions of physiological effects are not supported by empirical research. Rook's (1987) own evidence suggests that companionship may in fact buffer the effects of minor stressors, as participants in her study who reported greater levels of companionship had both a main effect and a buffering effect on psychological symptom levels. Participants who reported greater levels of companionship had fewer symptoms at both high and low levels of minor stress, although the effect was more pronounced at high levels of experienced minor stress.

Theorists such as Cohen and Wills (1985) propose that companionship has a supportive and stress reducing function due to its ability to fulfil a need for affiliation, distraction from worry and promotion of positive moods. Although companionship would not be expected to directly assist in solving the problem leading to the stressor, it might be particularly important in situations which are not amenable to control and coping efforts. Distraction may be important in preventing rumination on past stressors (Roger & Hudson, 1995; Roger & Najarian, 1997). The fostering of a positive mental state causes physiological changes in emotionally mediated immune functioning or behaviour patterns which may influence health (Jemmott & Locke, 1984; Kaplan, 1991). Cohen and Wills included companionship in a taxonomy of social support because they presumed the net effect is stress reducing, although they

examined only one study (Cohen & Hoberman, 1983) which used a measure of social companionship. In this study companionship was found to buffer both physical and psychological symptoms in relation to a life events measure of recent stress.

3.2.2 Stress buffering aspects of social relationships

The alternative mechanism linking social relationships to health is via stress buffering. Both Cobb (1976) and Cassel (1976) focused on the stress buffering aspects of social relationships. Cassel alluded to '*quality of group relationships*' and '*meaningful social contact*', however he left open the specific nature of social influence which lead to health benefits. Cobb's (1976 p.300) original definition of support was '*information leading the subject to believe that he is cared for and loved, esteemed, and a member of a network of mutual obligation*'. Cobb recognised social support as a feature of social integration, but specifically defined three components: *emotional support* - the feeling of being cared for, loving and being loved, *esteem support* - providing a sense of personal worth and ability and, *network support* - providing a sense of self identity and information regarding coping strategies and available social resources.

Cohen and Wills (1985) delineated four categories of social support which are potentially stress buffering, based on functional operationalization of support in studies they reviewed. These were: a) *esteem support* - information that one is accepted and valued; b) *informational support* - advice and guidance to help define and cope with stressful events; c) *social companionship* - others to spend time with in leisure activities and d) *instrumental support* - provision of tangible aid such as financial or material resources. Their classification subsumes the emotional and esteem support categories of Cobb into one category of esteem support and also includes provision of material goods. Cobb defined social support as information and therefore provision of material goods and services were specifically excluded as potentially fostering dependency. However, many later writers have included an element of material provision as an aspect of social support, termed *instrumental support* or

tangible support (e.g. Cohen & Wills, 1985; Schaefer, Coyne, & Lazarus, 1981).

A number of mechanisms can be suggested whereby social support can buffer stress. The knowledge that social support is available might lead a person to appraise an event as not threatening and therefore not provoking a stress response (cf. Cohen & Wills, 1985). Alternatively, information may lead to re-appraisal of a stressor as benign (Cohen & Wills, 1985).

Social relationships may facilitate the coping process by provision of advice or practical assistance. Guidance (Vaux, 1988), or informational support (Cobb, 1976; Cohen & Wills, 1985) can provide people with knowledge to help them resolve a stressor. Direct assistance (Vaux, 1988), or instrumental support (Cohen & Wills, 1985) refer to specific provisions or actions which a person supplies. Specifically, instrumental support may directly solve some stressors brought on by lack of tangible resources (Cohen & Wills, 1985). Information and guidance may aid the person towards finding their own solution. If stress is created by a loss of companionship, then a feeling of belonging may counteract this threat to identity (Cohen & Wills, 1985).

Both Thoits (1985) and Vaux (1988) refer to a function of social relationships termed respectively affect regulation or emotional regulation. This refers to *'palliative emotional support [is] aimed not at problematic events or appraisals of them, but at their emotional consequences'* (Vaux, 1988 p.141). This kind of support will alleviate negative emotional responses to stress such as anger, depression, anxiety etc.

3.2.3 Summary - how social relationships affect health

There are a number of pathways through which social relationships can potentially benefit health. These include alleviation of loneliness, provision of companionship, and promotion of healthier behaviours via social control. Mechanisms which might be

expected to be more effective at higher levels of stress include facilitation of behavioural and emotional coping. Some writers attempt to distinguish these functions on the basis of the proposed effects they have on health in relation to stress. The main bone of contention seems to be the desire by some writers to separate the stress buffering aspects of social relationships from the generalised effects. Such researchers would place any stress buffering aspects of social relationship under the term social support, whereas mechanisms which act not to buffer stress are subsumed under some other term e.g. companionship. This distinction does not seem to be useful in classifying functions of relationships, as many functional aspects of relationships can be seen to have potentially both stress moderation benefits and also to provide a more general enhancement to well-being independent of stressors.

3.2.4 Caveats on relationship provisions

When assessing relationship functions, it is important to distinguish the individual's perceptions of the relationship with what the other party to the relationship actually provides. For example, someone may believe their partner to be a source of social support when they actually provide little tangible assistance. It is not necessary for the transaction between the support provider and recipient to be recognised as supportive by those outside the relationship. The ability to perceive available relationships as supportive may be partly determined by the personal characteristics of the support recipient (Sarason, Sarason, & Shearin, 1986). In addition many behaviours designed to be supportive may be perceived as unsupportive (Antonucci & Israel, 1986). Verbal messages of support in particular can be prone to misinterpretation (Albrecht & Adelman, 1987; Goldsmith, 1994). Not all people will require the same level of social support in order to be satisfied with the relationship. This is important because satisfaction with the amount of support provided by relationships has been found to be related to health benefits (Seeman & Berkman, 1988). Support measures have therefore focused not only on the availability of support but also the satisfaction with what is provided (Sarason, Levine, Basham, &

Sarason, 1983).

Positive provisions of relationships as in Cohen and Wills' (1985) typology have been found to have buffering effects on symptomology when measured specifically, distinguishing between types of support, and when it is assessed amalgamating a number of support types into one measure. However, it is believed that support will be most effective in buffering stress when the resources supplied by the support most closely match the deficits produced by the stressor (Cutrona & Russell, 1990). Cutrona and Russell characterised different stressors by their impact in different life domains such as assets, relationships, achievements and social role, and events by their level of controllability. They suggested that specific stressors require specific types of support which match the stressful event. For example, a financial loss would be best ameliorated by instrumental aid, which in contrast would not be expected to be helpful if what was lost was a relationship. Some types of support are proposed to be generally beneficial in a number of situations, emotional support would be generally useful in uncontrollable events whereas controllable events benefit from informational support and esteem support.

Although previous research has often worked within the assumption that social support is only and always provided in close relationships, this has also been extensively challenged. Close relationships may not always be supportive or conflict free (Averill, 1982; Goldsmith, 1994). Accessing social support within a close relationship can have a number of negative consequences, for example, accepting social support may reveal weakness (DiMatteo & Hays, 1981). This has led to the study of the exact nature of transactions within relationships. By conceiving social support as communication based rather than relationship based, it is acknowledged that support may be gained even from people with whom no prior relationship has been established (Tardy, 1994). Field research would seem to bear this out as interactions between non-intimates may be regarded as providing support (Cowen, 1992).

Although the study of communication of social support has been suggested as the way forward for social support research (Albrecht & Adelman, 1987), it does not account for the non-verbal communication of social support. Relationships supply often implicit, subtle messages of acceptance, confirmation and liking which are not dependent on verbal communication (Burlinson, Albrecht, Goldsmith, & Sarason, 1994a). Tolsdorf (1976) defined social support as including any action or behaviour which assists in meeting demands of a situation, which does not limit social support to purely verbal transactions. Lehman and Hemphill (1990) include the non-verbal actions of just being there and listening, as components of emotional support. Dakof and Taylor (1990) also include physical presence in their taxonomy of helpful esteem or emotional supports and Barnes and Duck (1994) note the importance of the mere presence of another as a listener. Someone listening, can have 'ventilation features' which allow person to be less stressed even without the listener saying a word.

An alternative approach to the measurement of social support is to consider and measure the function of specific relationships (Pierce, Sarason, & Sarason, 1991; Pierce, Sarason, Sarason, Solky-Butzel, & Nagle, 1997). Weiss (1974) notes that a variety of relationships might be required to fulfil all provisions adequately and that an individual relationship generally does not fulfil all provisions. Thus there may be a role for relationship specialists which fulfil some or most aspects of support. Pierce, Sarason, and Sarason (1997) address this issue by measuring the qualities of individual relationships, their Quality of Relationships Inventory allows examination of aspects of support, depth and conflict for specific relationships.

3.3 Physiological effects of human relationships

One might infer from the data linking human relationships with decreased health problems during stress, and from the strong links between the physiological stress

response and health problems, that one mechanism which might underlie the association between human health and human social relationships was through reduced physiological reactivity to stressors. This suggestion dates as far back as the late 1950s (Bovard, 1959). The human studies have used two main approaches. The first examines tonic levels and reactivity of people with high levels of social support compared to those with low levels of social support. The second, which will be focused upon in this thesis, examines the effects of having a supportive companion present during a stressor.

3.3.1 Passive social support

Studies on social facilitation and affiliation pre-date physiological studies on effects of a supportive companion on stress reactivity. Despite the differences in terminology - affiliation, social facilitation and social support - the studies are very similar to each other, as all examine effects of companions on physiological reactions to stressors.

The social facilitation literature focused on explaining performance differences of participants with a person present. It was proposed that the presence of another person led to increased arousal, which in turn affected performance (Zajonc, 1965). However, evidence to support this increased arousal hypothesis was weak at the time it was proposed and more recent studies have continued to provide a mixed picture. A comprehensive meta-analysis by Bond and Titus (1983) was able to examine how galvanic skin response, palmar sweat index and heart rate were affected by the presence of others in 52 studies. Their analysis found that only palmar sweat index showed a small effect of physiological arousal from the presence of others and only during complex tasks. This effect was small and accounted for only 3.1% of the variance in arousal levels. There was no significant effect of audience presence on heart rate or galvanic skin response. This suggested that, although the presence of another might facilitate the emission of dominant responses, this was not directly synonymous with increased physiological arousal.

Affiliation represents another strand of research which pre-dates that on physiological effects of social support, but which addressed relevant issues. Affiliation studies established that, when waiting to take part in a potentially stressful experience, individuals prefer to be with others than alone (Schachter, 1959; Schachter, 1974). It was proposed that this was because affiliation provides a reduction in stress. Affiliation may be modified by the perceived benefits of being with others; in situations where others might lead to embarrassment or provide no benefit, less affiliation would be seen (Rofé, 1984). Friedman (1981) suggested that in an embarrassing situation, presence of evaluative others would be associated with *increased* stress compared to being alone. He supported this with data showing that participants waiting to take part in a potentially embarrassing experiment became more stressed as indexed by heart rate and GSR, when in the presence of another person. In contrast, those in a fear situation were less stressed if they could see another person. In Friedman's experiment, the participant and companion were not able to interact. Kissel (1965) found that the presence of a friend led to lower GSR when performing a stress task than being with a stranger or being alone. This was attributed to the positive feelings of being with a friend, which compete with the negative feelings produced by stress (Kissel, 1965). The task used in this study was neither fear or anxiety producing, and the companion was occupied with their own task, thus reducing the potential for embarrassment due to poor performance. Cacioppo (1990) has interpreted this finding in physiological terms by suggesting that human presence affects reactivity, either positively or negatively depending on whether the participant perceives the observer as adding to or reducing the threat posed by the stressor. However, the reduction of threat that might be communicated between the observer and the participant has only recently been termed social support, in conjunction with the rise in interest in social relationships and health.

The first study to examine physiological stress moderation from the presence of a passive familiar observer within a social support paradigm was that of Kamarck, Manuck and Jennings (1990). Their study differed from previous social facilitation

studies which had not focused on cardiovascular reactivity. Kamarck *et al.* decided to focus on cardiovascular reactivity, as they were interested to see if moderation of this by supportive relationships might explain the association between social support and health in general, and specifically cardiovascular health. Their study also differed from previous social facilitation studies by introducing the term social support to explain any stress moderation.

Kamarck *et al.* (1990) tested reactivity to standard laboratory stressors in two conditions, either alone or with a familiar observer. By including only these two conditions, it can be assumed that Kamarck *et al.* expected that the presence of a friend would moderate reactivity below that found when the participant completed the task alone. This again differed from the social facilitation literature which explicitly suggested that the presence of an observer was more arousing than being alone.

The studies which have explicitly focused on what they have termed social support, investigating the effect of the passive presence of a friend, can be split into two groups, those where the friend could be perceived by the participant as evaluative and those where the evaluative potential of an observer is removed. It had been suggested by social facilitation theory that an observer with an evaluative potential would be expected to increase autonomic nervous system arousal level. Although the observer in these studies would be a friend as opposed to a stranger, it was possible that this could increase evaluation potential further as this would be a person whose opinion could matter to the participant and thus poor performance in the presence of this observer would produce more social damage than being alone. Therefore, Kamarck *et al.* (1990) took steps to reduce the evaluative component of the situation by having the friend wear headphones which blocked out sound of the participant's responses and giving them a distracting task of their own to complete.

Kamarck *et al.* (1990) also had the friend touch the participant on the wrist to remind them of their presence. This was motivated by research which has documented

calming effects of human touch. The reduction in stress from human contact was first observed in laboratory animals being tested for other purposes¹. Gantt, one of Pavlov's associates noted the 'effect of person' which caused dogs' heart rate to decrease from the resting rate by 10-60 beats per minute during petting (cited in Lynch, 1977). Lynch and McCarthy (cited in Lynch, 1977) also showed that canine reactivity to an electric shock stressor could also be moderated when they were petted by humans. Further work by Lynch suggested that the reductions in heart rate seen in dogs (Lynch, 1969) could probably be generalised to other animals (Lynch, Fregin, Mackie, & Monroe, 1974a).

In humans the significance of any touch and the attribution given to it can alter the physiological effects. Touch can be arousing in a sexual nature, be seen to infringe personal space or be calming. The effect of human presence causing anxiety, has long been observed in the phenomena of 'white coat hypertension', in which the patient's blood pressure would be temporarily raised by the process of blood pressure assessment (Reeves, 1995). However, in the early 1970s, studies by Lynch and his associates demonstrated that comforting hand holding in coronary care facilities produced reductions and stabilisation of cardiac activity (Lynch, 1977; Lynch, Thomas, Mills, Malinow, & Katcher, 1974b)

Kamarck *et al.* (1990) found that the presence of the non-evaluative friend touching the participant on the wrist did reduce reactivity to the stress tasks compared to participants who carried out the tasks alone. There was a main effect of affiliative condition on systolic blood pressure and heart rate with reactivity to the tasks being lower in the friend present condition. This was not attributable to a distracting effect of the friend, as variables of number of responses per task and performance did not

¹For example, documentation of the reduction in cardiac activity in dogs to human affection can be traced back to the famous work of Pavlov on conditioning which used dogs. A usual increase in heart rate of 50-100 beats per minute of dogs in response to electric shocks was often eliminated and some dogs showed a decrease in heart rate from the resting session level when petted. Obrist also documents how in dogs being classically conditioned with an aversive electric shock, petting calmed them and reduced struggling and heart rate response to the shock (Obrist, 1981:59).

differ significantly between friend or alone conditions.

There were a number of mechanisms which were proposed for this effect including the familiarity of the partner, the physical proximity of another person, or differences in cognitive appraisal of the laboratory stressors. Kamarck *et al.* (1990) also acknowledged that differences in vocal stylistics in response to the verbal stressors might have caused differences in cardiovascular reactivity and that this could not be ruled out by their design. However, Kamarck *et al.* interpreted their results as indicating that a supportive observer could moderate cardiovascular responses to psychological challenges and that this is a potential mechanism behind the association of social support and health.

However, two further studies (Edens, Larkin & Abel, 1992; Snydersmith & Cacioppo, 1992) failed to replicate this early finding of reactivity being lower in the presence of a passive non-evaluative friend as opposed to when alone.

The study of Edens *et al.* (1992) aimed to further examine the role of touch in this type of experiment. In Kamarck *et al.*'s (1990) study, it was unclear whether the reduced reactivity was due to the physical presence of the friend or the touch on the wrist. Therefore, Edens *et al.* used a complex design with five between-subjects conditions where participants were tested either alone, with a friend present touching their wrist similar to the Kamarck design, with a friend present not in physical contact and with a stranger present touching their wrist or not in physical contact. Edens *et al.* took similar measures as Kamarck *et al.* to ensure that the observer was perceived as non-evaluative.

Although Edens *et al.* (1992) used two stressors, significant effects were only found for one task. The stranger conditions had higher heart rate and diastolic reactivity to the stressors than the friend conditions. This is in line with social facilitation research which found lower reactivity in when the observer was familiar as opposed to

unfamiliar. The effect of touch was to increase all cardiovascular variables compared to the no touch conditions. The significance of any interaction between factors of touch and observer type was not stated. However, it would appear from the graphs provided that touch might have increased diastolic blood pressure and heart rate reactivity more for stranger than friend groups. Edens *et al.* noted that participants reported higher levels of discomfort in the stranger touch condition which may have increased reactivity. The mixed results of Edens *et al.* and Kamarck *et al.* (1990) with regard to touch led to this variable being avoided by other researchers in the area.

As a direct comparison to the Kamarck *et al.* (1990) study, Edens *et al.* (1992) compared the alone condition and the friend touch condition but there were no significant difference in task levels. In a final analysis, Edens *et al.* compared reactivity to the mental arithmetic task, for the friend-no-touch condition and the alone condition. They found a significantly lower systolic blood pressure reactivity in the friend-no-touch condition than the alone condition. However, this comparison was only one of ten comparisons which could be made for either of the two tasks and on any one of the three dependent variables, i.e. one out of sixty possible comparisons. Generally speaking, accepted significance levels of unplanned post hoc tests should be adjusted to control for the fact that multiple comparisons might be made which would inflate the chance of detecting a significant difference when it does not exist. If this had been done, then the difference observed by Edens *et al.* would not be considered significant.

The experiment of Snydersmith and Cacioppo (1992) also compared effects of presence of a friend as opposed to a stranger on reactivity to standard laboratory stressors. In line with previous social facilitation experiments, Snydersmith and Cacioppo chose to investigate the effect of social support on skin conductance and heart rate rather than blood pressure. Participants were tested in one of three conditions, alone, with a stranger observing them or with a friend observing them during two sets of mathematical problems. As in Edens *et al.* (1992), Snydersmith and

Cacioppo found that participants in the stranger condition had higher reactivity as measured by heart rate and peak skin conductance levels than those who were alone. In addition, the skin conductance change from anticipatory levels to task levels was greater for those in the stranger condition than those alone or with a friend. However, there were no differences between the alone and friend conditions.

It had been suggested in social facilitation literature that evaluation can increase reactivity (Bond & Titus, 1983). Confirming this pattern, two studies which did not remove the evaluation potential of their friend condition have found increased reactivity as compared to being alone (Allen *et al.*, 1991), or no differences between stranger and friend presence (Sheffield & Carroll, 1994). In both of these experiments, the friend was able to evaluate the performance of the participant. Supporting the suggestion that friends may be seen as more evaluative than strangers, Sheffield and Carroll's participants reported that friends were seen as significantly more evaluative than the stranger.

To clarify these results, a recent experiment by Kors, Linden and Gerin (1997) included an evaluative and non-evaluative friend present condition to contrast against an alone condition. The evaluation potential was manipulated by having the friend, who sat about 1.5m away, either able to see the questions and answers of the participant or unable to see the questions and answers. Participants in the non-evaluative condition had significantly less systolic blood pressure reactivity than those in the alone condition, although there were no differences between the conditions in diastolic blood pressure or heart rate. Kors, Linden and Gerin also found that both closeness and length of the friendship were negatively correlated with systolic blood pressure reactivity. Their results appeared to clarify that for a friend to be supportive the evaluative component should be removed. However this study does not establish that presence of a non-evaluative friend produces lower reactivity than when alone.

An alternative explanation for the mixed results was proposed by Kamarck, Annunziato and Amateau (1995). Kamarck *et al.* argued that the effects of a supportive other reducing stress reactivity below that seen when alone, were reliant on boundary conditions of low evaluative but supportive partner, and also would only occur under conditions of high social threat. Kamarck *et al.* defined social threat as a situation where there could be social consequences or a withdrawal of social approval. They argued that the experiments of Edens *et al.* (1992) and Snydersmith and Caccioppo (1992) although having removed the evaluation potential had been carried out in lower formality settings than the Kamarck *et al.* (1990) original experiment and had used cognitive tasks where there might be less potential for social support to have benefits and this was why they failed to replicate the results.

To test this hypothesis, in their 1995 experiment, Kamarck *et al.* manipulated both the social threat of the situation and availability of support. Threat was manipulated by the actions of the experimenter, the companion, when present was non-evaluative. In the high social threat situation, the experimenter, introduced as 'doctor', was formally attired, brusque during a pre-experiment interview, gave instructions in an impatient manner and prompted participants during the task to improve performance. In the low threat conditions, the experimenter was introduced by his first name, informally dressed and acted in an empathic manner during the pre-experiment interview. He gave the instructions in a calm manner and no prompts were made during the task.

The results confirmed Kamarck *et al.*'s hypotheses of high threat being necessary for social support to have any effect. Generally, the reactivity of systolic blood pressure and diastolic blood pressure was higher in the high threat condition than the low threat condition. However, there was a predicted effect on reactivity of the interaction between threat condition and social support condition.

A slightly different formulation was made by Gerin *et al.* (1995) that social support

might have a buffering effect only in high stress situations. Gerin *et al.* used a within participants design to examine effects of the presence of a supportive other on reactivity. In the high social threat setting, the participants were 'harassed' by the experimenter to perform the computer game stress task more quickly. The levels of support were varied by, in the companion conditions, having the participant's roommate present to '*root for her, although not out loud*', or having the participant complete the task alone (Gerin *et al.*, p.18).

The pattern of results for Gerin *et al.* (1995) was similar to those of Kamarck *et al.* (1995). High stress conditions produced greater reactivity but there was the predicted interaction between social support condition and stress condition. Reactivity was higher for high stress settings when alone than when with a friend, however, social support condition did not affect reactivity in low stress conditions.

Thus it appears that under high stress conditions and where the support provider is non-evaluative, the mere presence of a friend can reduce reactivity below that expected when the participant is alone. The outcomes of these studies are summarised in Table 3.1.

None of these studies have manipulated supportive actions or verbal communication by the observing friend, it is only by their relationship to the participant that they are presumed to be supportive. All the participants in these experiments were instructed to be supportive to their friends. The mixed results in these studies may attest to the fact that a person is not always supportive in a stressful situation. This can be highlighted by the ratings in Sheffield and Carroll's (1994) experiment where the friend was actually seen as more evaluative than the stranger and of similar supportiveness. This would not differ from the social support literature which demands that the support provided should be commensurate with the person's needs and that even well intentioned support may be misconstrued.

Table 3.1 Design features of studies examining stress reduction from the passive presence of a human companion

Study	Participants	Stressor(s)	Support Conditions	Support Actions	Support pattern of results (only significant differences shown)
Kamarck, Manuck & Jennings (1990)	N=39 f m=18.8y	verbal mental arithmetic, verbal concept formation	friend or alone	<i>Non Evaluative</i> - wore headphones, touched participant on wrist and given own task	SBP friend < alone (math task only) DBP n.s. HR friend < alone (both tasks)
Allen <i>et al.</i> (1991)	N=45 f 27-55y m=39y	verbal mental arithmetic	friend, pet dog or alone	<i>Evaluative</i> - sat near to participant and able to hear answers.	GSR dog < alone < friend SBP dog < alone < friend DBP & HR n.s.
Edens, Larkin & Abel, (1992)	N=60 f	verbal mental arithmetic, silent mirror tracing	friend (2), stranger (2), or alone.	<i>Non Evaluative</i> - wore headphones, given own task <i>Non Evaluative Touch</i> - as above + touched participant on wrist	SBP n.s. DBP & HR friend < stranger (math)
Snydersmith & Caccioppo (1992)	N=34 f 17-25y	verbal mental arithmetic tasks	friend, stranger, or alone	<i>Non evaluative</i> - sat behind participant, not able to see questions, but able to hear answers	GSR alone = friend < stranger HR n.s.
Sheffield & Carroll (1994)	N=120 m/f 17-35y m=21.1y	silent mental arithmetic, silent vocabulary test	friend, stranger, or alone	<i>Evaluative</i> - sat next to participant and listened to questions	SBP, DBP & HR n.s.
Gerin <i>et al.</i> (1995)	N=26 f 17-21y	silent computer game playing	friend or alone.	<i>Evaluative</i> - sat next to participant watching game	threat x support interaction, SBP & DBP supp. < alone HR supp. < alone ($p=.07$)
Kamarck, Annunziato & Amateau (1995)	N=96 f 18-30y m=20	Stroop task	friend or alone	<i>Non Evaluative</i> - wore headphones, touched participant on wrist, given own task	high threat setting , SBP & DBP supp. < alone HR n.s.
Kors, Linden & Garvey (1997)	N=50 f m=20.4y	silent mental arithmetic	friend (2) or alone	<i>Evaluative</i> - sat in view of math questions and answers <i>Non Evaluative</i> - unable to see math task and given own task	SBP non eval < alone; but non eval = eval & eval = alone DBP & HR n.s.

3.3.2 Active communication of social support

In contrast to the previous experiments which have examined the effects of passive silent support, there is also a series of studies which have examined what might be termed the effects of more conventional support on physiological reactivity. These experiments have used scenarios where a person, often unfamiliar to the participant, makes a comment or engages in behaviour designed to be supportive. As a companion animal arguably cannot provide an active form of social support in a laboratory situation, these studies will not be examined in detail. A summary of their designs is given in Table 3.2.

The effects of active support seem more potent than passive support in producing moderation of reactivity. Studies of Lepore and colleagues (1995; 1993) have found that presence of a supportive stranger during a speech presentation reduces reactivity below that of an alone condition. Christenfeld *et al.* (1997) investigated whether a stranger was as effective as a friend in provision of support. Their results seemed to imply that a stranger was as effective as a friend, as reactivity on both diastolic blood pressure and heart rate was similar for these two conditions, although the friend did produce lower reactivity than the supportive stranger for systolic blood pressure.

Glynn *et al.* investigated the potential effect of supportive males versus supportive female strangers. Provision of support from a female was more potent, moderating reactivity for all cardiovascular variables, whereas male support only moderated heart rate. Neither the Christenfeld *et al.*, (1997) nor the Glynn, Christenfeld and Gerin (1999) study compared reactivity to an alone condition. Sheffield and Carroll (1996) also found that a supportive companion moderated reactivity, but only in relation to an unsupportive companion and not relative to their alone condition.

Table 3.2 Design features of studies examining stress reduction from the active presence of a human companion

Study	Participants	Stressor(s)	Conditions	Support Actions	Support pattern of results reactivity
Gerin <i>et al.</i> (1992)	N=40 f age not given	debate - with two harassing opposing confederates + stranger companion	stranger (2)	<i>Support</i> - made an agreeing statement and supportive body language <i>Neutral</i> - no comment, non responsive body language	SBP, DBP & HR supp. < neutral
Lepore, Allen & Evans (1993)	N=90 m/f m=20.8y	speech task to companion	stranger (2) or alone	<i>Support</i> - encouraging body language and agreeing comments <i>Neutral</i> - non responsive body language	SBP supp. < alone < neutral DBP supp. = alone < neutral
Lepore (1995)	N=104 m/f no age given	speech task to companion	stranger or alone	<i>Support</i> - sat in room with participant, listened to speech, made supportive comments	SBP, DBP & HR supp. < alone
McNeilly <i>et al.</i> (1995)	N=30 Af Am f 18-33y	debates - sensitive issue, & racial issue (against White confederate)	African American female stranger (2)	<i>Support</i> - made an agreeing statement and supportive body lang. <i>Neutral</i> - no comment, non responsive body language	SBP, DBP & HR n.s.
Sheffield & Carroll (1996)	N=90 m/f 17-35y m=21.6y	verbal judgement task with companion	stranger (2) or alone	<i>Support</i> - agreed with participants judgements <i>Negative</i> - disparaging, disagreed with participants judgements	SBP & DBP n.s. HR alone < neg
Christenfeld <i>et al.</i> (1997)	N=90 f m=19.5y	speech task to companion	supportive friend or stranger (2)	<i>Support</i> - encouraging body language and agreeing comments <i>Neutral</i> - non responsive body language	SBP friend < supp. stran. < neu. stran DBP & HR friend = supp. stran < neu. stran
Uchino & Garvey (1997)	N=49 m/f no age given	speech task (no audience)	experimenter (2)	<i>Support</i> - statement made by experimenter of potential support <i>Neutral</i> - no statement	SBP & DBP supp. < neutral HR n.s.
Glynn, Christenfeld & Gerin (1999)	N=109 m/f m=19.7y	speech task to companion	male stranger (2) or female stranger (2)	<i>Support</i> - encouraging body language and agreeing comments <i>Neutral</i> - non responsive body language	for female audience only SBP & DBP supp < neutral, both audiences HR supp < neutral

Other experiments have used debate stressors where it was not feasible to have an alone condition (Gerin, Pieper, Levy, & Pickering, 1992; McNeilly *et al.*, 1995). Gerin *et al.* (1992) found that presence of a supportive condition during a heated debate with two confederates reduced reactivity below that seen when the companion was neutral. However it should be noted that McNeilly *et al.* (1995), using a similar procedure, failed to replicate this finding.

All these experiments included the possibility for the companion to evaluate the performance of the participant. However, with the exception of Uchino and Garvey (1997), the supportive companion gave feedback to the participant that their performance was being evaluated favourably, and this presumably reduces the threat associated with an evaluative but uncommunicative observer which might increase reactivity to a task.

In contrast to the passive companion studies, which all included an alone condition, 5 of the 8 studies of active support did not include an alone condition. Kamarck *et al.*'s (1990) initial rationale that presence of a supportive companion could reduce reactivity and thus lead to health benefits, was made in reference to conditions where no companion is present. Therefore if studies do not demonstrate a reduction in reactivity relative to an alone condition, it is difficult to see how they can link to Kamarck's rationale. It is arguable that everyday stressors most often occur in the presence of other people, and therefore the option in this scenario is either presence of a supportive or unsupportive companion. However it would be necessary to ensure that the difference in reactivity between supported and unsupported conditions was due to the supportive companion reducing the reactivity, rather than just the unsupportive companion increasing reactivity.

Despite the somewhat mixed results, the above experiments have been interpreted as demonstrating that the presence of a supportive other can reduce reactivity to a stressor. For example, in their review paper on social support and physiology,

Uchino, *et al.*, (1996 p.505) summarise the findings of these studies as "*social support may reduce cardiovascular (or autonomic nervous system) reactivity to acute psychological stress*". This then would appear to provide a potential mechanism through which supportive relationships might confer a health benefit.

3.4 Conclusions

The evidence linking the presence and quality of human social relationships with human health is substantial and convincing. Many studies highlight the link between social networks and health as measured by mortality from all causes, and specific morbidity from cancer, heart disease, etc. The consideration of the potential mechanisms which might link our relationships with other humans could provide a framework for examining how our relationships with other animals might enhance well-being. The way in which human-animal relationships may plausibly fit the model of social support is discussed in Section 4.3.1. However it is first necessary to examine whether an association between human-companion animal relationships and enhanced well-being exists. This is presented in the next chapter.



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4.2 Benefits of pet-ownership

4.2.1 Psychological well-being

The first study to examine effects of pet-ownership on well-being was that of Mugford and M'Comisky (1975). They studied elderly people aged 75-81 years who lived alone. Participants were randomly allocated to control groups or given either a budgerigar or Begonia plant. After five months, participants in the budgie groups, had a significant improvement in *'attitudes towards themselves and other people'* which was not seen in the control or Begonia groups. Participants given the budgies reported that the bird had become a focus of interest and all had become enthusiastic pet-owners.

However, there was a 40% drop out rate of participants which meant that final results were based on comparisons of seven budgie owners, eight Begonia owners and four control participants. The low number of participants meant that Mugford and M'Comisky had to analyse their data in terms of numbers of questionnaire items showing positive, negative or no changes between the three groups, rather than total score per group. Thus the validity of their analysis strategy appears dubious.

More interestingly, although this experiment is frequently cited as demonstrating the health benefits of birds to people, the effect was not reciprocal as there was a 50% budgie mortality rate in the first six weeks of the study. This raises serious concerns for the welfare of animals in this type of research. It may not be acceptable to randomly allocate participants to pet owning conditions in a manner which is methodologically desirable, as some people may not have the ability or motivation to provide adequate care for the animals. Therefore, all other studies have used a quasi-experimental design where they have examined differences in pre-existing pet owning or pet seeking populations.

Mitigation of loneliness is a frequently cited benefit of pets (Beck & Meyers, 1996). There have been two studies which have examined loneliness in pet-owners and non-owners. Goldmeier (1986) found that participants 'living alone with a pet' were significantly less lonely than those 'living alone without a pet', although they were still significantly more lonely than those 'living with other people' regardless of the presence of a pet. Similar results were reported by Zasloff (1994) who found that women 'living alone with no pet' reported themselves as significantly more lonely than women 'living alone with a pet'. Thus it seems that pet ownership may be useful in alleviating loneliness for people living alone.

Findings for anxiety are however less clear. The studies of Watson and Weinstein (1993), Straede and Gates (1993) and Friedmann, Katcher, Eaton and Berger (1983a) report no differences between pet-owners and non-owners in terms of trait anxiety (Spielberger, 1983). Friedmann, Katcher, Lynch and Thomas (1980) reported no significant differences in anxiety between pet-owners and non-owners in their post coronary care patient group although they do not mention the scale used.

Although one study has reported lower anxiety in pet owners than non-owners (Fritz, Farver, Kass, & Hart, 1995), under closer examination these claims do not appear substantiated. Fritz *et al.* measured 32 non-cognitive indicators of psychopathology in Alzheimer's patients. Anxiety of patients living with pets tended to be lower but was *not significantly* so ($p=.062$), using conventionally acceptable levels of significance. Only verbal aggression was significantly ($p<.05$) less in pet-exposed patients. Given the multiple comparisons being made, this would not be regarded as a conclusive result. Thus the study of Fritz *et al.* does not really provide any support for lower anxiety in pet-owners than non-owners in this special population.

Similar non-significant results are seen when examining the studies comparing depression levels between pet-owners and non-owners (Akiyama, Holtzman, & Britz, 1986-87; Friedmann *et al.*, 1980; Fritz *et al.*, 1995; Garrity, Stallones, Marx, &

Johnson, 1989; Goldmeier, 1986; Stallones, Marx, Garrity, & Johnson, 1990; Straede & Gates, 1993; Watson & Weinstein, 1993). These studies have examined a variety of populations i.e. bereaved widows (Akiyama *et al.*, 1986-87), middle-aged working women (Watson & Weinstein, 1993), Alzheimer's patients (Fritz *et al.*, 1995), cross-sectional populations of both middle-aged and older adults (Garrity *et al.*, 1989; Stallones *et al.*, 1990) and have used established depression scales such as the Centre for Epidemiological Studies Depression Scale (Radloff, 1977) and the Beck Depression Inventory (Beck, 1987), and none of them report any significant differences between owners and non-owners.

An exception to this pattern is the recent study of Siegel, Angulo, Detels, Wesch and Mullen (1999) which found lower incidence of depression in pet owning men with few (≤ 3) human confidants and an AIDS diagnosis compared to non pet owners. The moderation did not hold for men with four or more confidants. Therefore although pets may be an important social resource for this exceptional population facing both low social support and a stressful illness, it seems that pet ownership per se is not associated with lower depression scores for most other population groups.

Other aspects of psychological well-being have been examined in studies of Straede and Gates (1993), Kidd and Feldmann (1981), Bonas, (1999) and Bolin (1987). In the main these have found non-significant differences between pet owners and non-owners. The General Health Questionnaire (GHQ) (Goldberg & Williams, 1988) is a standard measure of psychiatric well-being focusing on broad components of psychiatric morbidity such as anxiety and depression (Bowling, 1997). Straede and Gates found that their cat-owners had better scores on the GHQ than the non-owners they surveyed. However, they noted (p.37) that, despite the study sample being drawn from the general population, mean scores in the non-owning group were above the level used to identify individuals in need of psychiatric help.

In a survey of pet owning elderly adults, Kidd and Feldmann (1981) found that pet-

owners reported themselves as significantly more '*benevolent and helpful*', more '*independent and self-sufficient*' and more '*optimistic, poised and productive*'. However it should be noted that these were only 3 of the 24 scales administered and had multiple comparisons been controlled for, no significant differences would have emerged. Bonas (1998), measuring psychological mental health using a symptom checklist found no effects of pet ownership on psychological symptoms. Bolin (1987) found no significant differences on 9/10 scales of adjustment to bereavement, including those relating to despair, somatic problems and sleep disturbance. Only a scale of guilt significantly differed the pet owners and non-owners, and again this would not have remained significant had controls for multiple comparisons been made.

One reason for the failure of studies to find differences by pet ownership per se, is that it does not take into account the nature of the relationship that the person has with the animal. Although the majority of the studies have found no benefits to psychological health when purely examining presence of a pet in the household, some have found significant differences results when examining qualitative differences in the type of relationship. However this raises the problem of how to interpret such correlations. For example, Garrity *et al.* (1989) found that attachment to pets was *negatively* correlated with depression scores. This was taken as a suggestion that attachment is related to enhanced emotional status. However, Keil (1998) found that loneliness and worry were *positively* correlated to 'pet attachment' and this relationship was stronger for those without human confidants. Keil suggested that the findings demonstrated that pets were an important social resource for older adults. Therefore it seems that authors can interpret their findings in any way to indicate a benefit from pets.

Other studies, assume a causal relationship in correlational studies. For example, Fritz *et al.* (1995) found that Alzheimer's patients who spent most time interacting with their pet had reduced anxiety and non-cognitive symptom levels, whereas presence of a pet in the household was not a significant factor. This might suggest that

relationship with the pet is an important variable, but as this was a correlational study, no causal direction should be inferred. It is equally likely that those evidencing more symptoms would be less likely to be interacted with by the pet, or that these symptoms might indicate disease progression which may also affect ability to interact with an animal, as the interaction with the pet had an ameliorative effect on symptoms as suggested by the authors.

In conclusion, the evidence that pet-ownership mitigates loneliness is more conclusive than evidence for any other type of psychological well-being. Pet-ownership does not seem to have any effect on levels of anxiety or depression in general populations. Other scales of psychological well-being have shown some advantages to pet-owners (Bolin, 1987; Kidd & Feldmann, 1981; Mugford & M'Comisky, 1975; Straede & Gates, 1993), however, the singular use of these measures precludes conclusions being drawn.

4.2.2 Cardiovascular health

Historically, the investigation of the beneficial implications of pet-ownership really took off with the publication of a study which reported increased survival after coronary events in pet-owners as compared to non-owners (Friedmann *et al.*, 1980). Although, previous studies had begun to implicate a link between social conditions, social isolation, social support and prediction of myocardial infarction, at the time, only a few studies had examined survival after coronary events. Friedmann and colleagues decided to examine the influence of social factors which predicted coronary events, on survival for one year after an initial diagnosis of either angina pectoris or myocardial infarction. Pet ownership was included as one item in the inventory on social factors.

As expected, physiological severity accounted for the largest portion of the variance - 21% in survival. However, pet-ownership added a significant further 2.5% of the

variance in mortality. Three of the 53 pet owners died (6%), compared to 11 of the 29 non pet owners (72%). Analyses demonstrated a significant effect of pet-ownership on survival for both dog and cat owners. Thus suggesting that the difference in survival of pet-owners was not due to healthy dog-owners who were required to take more exercise. Although Friedmann *et al.* report a further discriminant analysis in which eight variables accounted for 39.5% of the variance in survival, pet-ownership was the least predictive and it is not reported whether pet-ownership made a significant contribution when other variables were taken into account. Friedmann *et al.* found no evidence for differences in tension, anxiety, depression, confusion, vigour or fatigue between pet-owners and non-pet-owners that might account for their findings. Although they did not analyse differences in social conditions. Their conclusions were that pets were an important social resource which could aid survival after coronary event.

In a comment on the paper, Wright and Moore (1982) argued that, although pet-ownership itself had a significant relationship with survival, this variance was shared with other variables and so the association can be explained by differences in social factors between pet-owners and non-owners. Wright and Moore therefore concluded that the beneficial effect of pet ownership was a statistical artefact. Furthermore, they made a recommendation that professionals and public should be made aware that the connection between pet-ownership and CHD survival was spurious.

Wright and Moore's (1982) comments seem to rest on Friedmann *et al.*'s (1980) choice of pet-ownership as the second variable in the initial analysis. Friedmann *et al.* provide no justification for why this variable above all others was examined in this manner. Although pet-ownership was one of the social factors examined as a potential predictive factor, it was only one item in a large inventory which suggests that it was not initially considered a focus of the study. Supporting this assertion, pet-ownership was not specifically mentioned in either the introduction or conclusion of Friedmann's (1978) thesis on which the paper was based. This suggests that association of pet

ownership and survival might be a finding which emerged post hoc.

Although Friedmann and Katcher (1982) acknowledged that their results may have been over interpreted and exaggerated, they defended their conclusions that pet-ownership was an important factor determining survival as this was a significant predictor even when both age and severity of heart disease were statistically held constant. There were no further published comments on this study, and so, despite the unclear rationale behind Friedmann *et al.*'s (1980) isolation of pet-ownership as an important factor in predicting survival post coronary events, the results were interpreted as suggesting that pet-ownership would help lengthen survival after coronary disease. The paper provoked huge interest in human-companion animal relationships and the use of pets in therapeutic settings and it is still arguably the most influential and most frequently cited of all the papers on pet-ownership and health.

The results of Friedmann *et al.* (1980) have been partially replicated by the more recent Cardiac Arrhythmia Suppression Trial (CAST) (Friedmann & Thomas, 1995) which also examined factors contributing to survival after myocardial infarction. There was a tendency for pet-ownership and social support to predict survival rates when physiological severity of demographic and other factors were controlled. Dog-owners were less likely to die than non-pet-owners, however, cat-ownership was a significant predictor of mortality. Cat-owners were more likely to die than any other group, although this association reduced when human social support was taken into account. Exercise was not examined in this study, therefore it is not possible to examine whether this pattern was due to increased physical activity in the dog owning group.

However, a recent British study which replicated the design of Friedmann *et al.* (1978) found no benefits of pet ownership. Rajack (1997) examined aspects of psychological and physical health of patients for a six month follow-up after incidence of myocardial infarction. No differences were found in health of pet owners and non owners, even

when examining people who reported little human social support. Therefore it seems a moot point whether pet relationships can be regarded as similar to human social support which has been shown to increase survival after MI (Ruberman *et al.*, 1984).

However, pet-ownership has been linked to other aspects of cardiovascular health. Anderson, Reid and Jennings (1992) in a large scale survey of Australians, found that pet-owners had lower levels of known physiological risk factors for cardiovascular disease. Male pet-owners had significantly lower systolic blood pressure, and levels of plasma triglycerides and cholesterol. However, among females, pet-owners had an improved status on these risk factors only in the over 40 age category and only in terms of lower systolic blood pressure. However, the incidence of pet ownership in this study (14%), was much lower than found in the National People and Pets survey on Australian pet ownership (McHarg *et al.*, 1995) which found a 60% pet ownership rate. Therefore it is not certain whether Anderson *et al.*'s pet owners were representative of the general pet owning population.

Although the differences in absolute terms on the physiological factors between the two groups was very small, the authors have calculated that even these small alterations could result in a reduction in 4% of the risk of heart attack. The authors (Anderson *et al.*, 1992) do caution that their findings do not mean that acquisition of a pet will lower these risk factors in individual cases. Nonetheless, their results have been interpreted rather more sweepingly. Patronek and Glickman (1993) state that 50-70% of persons currently at risk of coronary heart disease who are not pet-owners could potentially benefit if they acquired a pet, which assumes a causal link.

Two further pieces of evidence suggest that these lower risk factor levels might be translated into lower clinical incidence of disease (Jennings *et al.*, 1998). First, preliminary evidence suggests that at least amongst men, pet-ownership is associated with a lower rate of diagnosis of angina. For male participants, 43% of those who were diagnosed were pet-owners compared with 70% of a control group matched for

age and cholesterol level, difference significant $p < .01$. It is not reported how many cases these results are based on, and there was no effect for females with slightly more pet-owners in the diagnosis group than the control group, however the full results should be interesting. Second, the Australian People and Pets survey also documented a significantly lower self report rate of use of medication for heart problems, high blood pressure or high cholesterol amongst pet-owners (Jennings *et al.*, 1998).

However, in a retrospective study, Rajack (1997) found no association between incidence of angina, myocardial infarction, hypertension or other heart problems and pet-ownership history.

In conclusion, there is conflicting evidence for a link between cardiovascular health and pet-ownership. The initial Friedmann study, and subsequent American and Australian studies, have found associations between pet-ownership and cardiovascular health. However British studies have not found similar effects.

4.2.3 Reduction in minor health symptoms

Pet-ownership has not been associated with any other specific physical health benefits other than those related to cardiovascular health. However, acquisition of a pet dog or cat has been associated with a reduction in minor health symptoms. Serpell (1991) followed pet-owners for 10 months after they had acquired a pet. He found that participants acquiring a dog reported reductions in minor physical health problems at 1, 6 and 10 month follow-ups and fewer psychological health problems at 6 and 10 month follow-ups. Cat-owners also reported initial reductions in minor health problems, however these were not sustained to 6 and 10 month follow-ups. Serpell also found, not surprisingly, that dog-owners significantly increased the amount of exercise they gained in the form of walking after acquiring their pet, however the effects of this increased exercise regimen on health were not examined.

The three other studies which examine incidence of minor health symptoms in cross-sectional design find no advantages for pet owners.

Akiyama, Holtzman and Britz (1986-87) examined the incidence of 40 physical complaints or indications of illness in recently bereaved widows. The total health scores did not differ significantly between the groups. Therefore Akiyama *et al.* went on to examine each symptom individually. Pet owners reported a significantly lower incidence of symptoms of constipation, difficulty in swallowing, persistent fears, cold sores, migraines, feelings of panic and drug intake, however none of these differences would reach significance had the appropriate controls for multiple comparisons been taken.

Bolin (1987) claimed that close human-dog relationships are helpful in the process of bereavement. This claim appears to be based on the self-report of non-owners that their health was good before the death and poor afterwards whereas pet-owners reported had no such deterioration. However, no detail is reported as to how health was measured and with no analyses to support these claims, it remains unsubstantiated. In analyses which are reported, there was no significant difference in pet owners and non-owners scores on a somatization scale which reflects incidence of minor health problems.

Bonas (1998), found no differences in physical symptom levels reported by pet-owners and non-owners, even when recent stress levels, support levels from pet and human social support were statistically controlled.

Therefore, on balance it seems that there is not robust evidence for a decrease in minor health problems amongst pet-owners, with only one study (Serpell, 1991) finding beneficial effects. These effects were found only in dog owners and may have been due to increased exercise levels.

4.2.4 Use of health care services

Studies in America (Siegel, 1990), Canada (Raina, Bonnett, & Waltner-Toews, 1998) and Australia (McHarg *et al.*, 1995) show less frequent use of health care services amongst pet-owners than non-owners.

Siegel (1990) found that pet-owners have significantly fewer physician contacts over a year than non-pet-owners, controlling for health status and depression. This lower level of utilisation in pet-owners was attributed to a possible stress moderating effect, although a relationship only existed for dog-owners and not owners of cats or other species. Raina, Bonnett and Waltner-Toews (1998), using data from a Canadian Medical Insurance Plan, found that pet-owners had fewer encounters with the healthcare system than non-owners. Pet-owners also cost less to the insurer and stayed in hospital for a shorter length of time than non-owners. McHarg *et al.* (1995) also found that Australian pet-owners visited the GP less frequently than non owners.

Anderson and Headey (1995) estimated that, if the McHarg *et al.* (1995) findings were replicated across all Australian pet owning households, this would lead to annual health care budget savings in excess of Aust. \$790 million. Their paper implicitly implies that pet-ownership should be encouraged as health benefits are attributable to their presence. However, it should be noted that their analysis ignored the well established health costs of pet-ownership such as bites (Voelker, 1997), infections (Tan, 1997), parasites (Plaut *et al.*, 1996), aggravation of allergies (Pletscher, 1991) and increased respiratory disorders (Abdulrazzaq, Bener, & Debuse, 1995). As noted by Allen (1997) consideration of health implications of pets should take into account the health disadvantages as well as advantages.

Two studies find no differences in pet-ownership and illness behaviour (Garrity *et al.*, 1989; Stallones *et al.*, 1990). These studies both computed an illness score based on recent previous use of physician services, hospitalisations, illness related reductions in activity and prescription drug use. In older adults (65+) Garrity *et al.* found no general

relationship between pet-ownership or depth of relationship to pet, on reports of recent illness behaviour. However, among pet-owners who reported fewer human confidantes, those who reported stronger relationships with their pet had a lower recent illness score than those who were less strongly 'attached', thus suggesting a possible health benefit at low levels of human support. Stallones *et al.* found no association between pet-ownership and recent illness behaviour sample of adults aged 21-64. Nor did attachment to the pet seem to make any difference, as there was no difference in illness between high and low attached owners.

The evidence of reduced health care service utilisation in pet-owners is mixed. However, whether a reduced number of physician visits can be used as an index of improved health status or stress buffering in pet-owners is debatable. Increased stress can be related to increased illness behaviour in the absence of physiological pathology (Cohen & Williamson, 1991). Both denial of health problems and over attention to symptoms can be seen to be consequences of stress which affect utilisation of physician services (Lin & Peterson, 1990; Miller, Brody, & Summerton, 1988). This makes health service utilisation a more distal variable to health, although it is arguably one that attracts economic attention.

However, reluctance to seek medical health at an early stage in a illness can result in greater and more costly health problems (Matthews, Siegel, Kuller, Thompson, & Varat, 1983; Smith & Leon, 1992). If pet-owners feel as ill as non-owners but do not visit the doctors, then this could be a higher cost long term strategy. It could be argued that pet-owners might be unable to utilise health care services as frequently or for as long because of constraints in looking after their pet.

Although on balance there seems to be more evidence in favour of reduced health service utilisation in pet owners, it is not clear whether reduced illness behaviour in pet-owners can be regarded as either a sign of stress buffering or increased physical health. As these findings are at odds with the non-significant findings when examining

levels of minor health symptoms, researchers should examine why pet owners do not seek medical help and whether this is due to improved health or due to lifestyle constraints.

4.2.5 Longevity

At present only one study has attempted to examine whether pet-ownership was linked to longer life span (Tucker, Friedman, Tsai, & Martin, 1995). This study found no relationship between reports of time spent playing with pets and longevity. However, interaction and pet-ownership was not a focus of the study and it is arguable whether 'playing with pets' is an adequate item to assess either pet-ownership or relationship with a companion animal.

4.2.6 Conclusions on the association of pet-ownership and human health

The research suggests that there are no differences between pet-owners and non-owners on measures of depression or anxiety. The results are mixed and generally negative with respect to other aspects of psychological health and incidence of minor physical health problems. There are mixed but more positive results for cardiovascular health, mitigation of loneliness and the more distal variable of use of health care services. Therefore, the evidence for a strong association between pet-ownership and health is equivocal. Some of the mixed results may be attributed to poor methodology or design, or simplification of the concept of pet-ownership without taking into account the depth of relationship. However, the range of studies finding some association suggests that there is a reason to investigate why this association might be occurring (Bonas, Dunn, & Heathcote-Elliott, 1996).

4.3 What might underlie the association of pets with well-being?

A variety of mechanisms have been proposed to explain benefits which might arise from pet-ownership. In Friedmann *et al.*'s classic article (1980), exercise differences and prior personality or health differences were discounted as reasons for the health benefits seen in pet-owners. The provision of pets as a regulator and impetus for activities, source of love, direct physiological effects of contact comfort, direct physiological effects of watching animals and benefits for interaction without speech were however suggested as plausible mechanisms. Since that time, the focus on searching for mechanisms underlying the association between pet-ownership and health has focused on physiological effects and an amorphous category of attachment, social support and depth of relationship with little examination of non-causal associations.

McNicholas and Collis (1998a) have recently brought together these various types of explanations into a tri-partite model as shown in Figure 4.1. This has provided a base for further research in the area by organising the classes of explanation.

Collis and McNicholas (1998) point out that direct explanations might be due to either the relationship between the person and their pet or through direct physiological effects as alluded to by Friedmann and colleagues (1995; 1983b). Under the heading of indirect effects, can be included suggestions that health benefits may be due to increased exercise or increased interaction and formation of human relationships which might occur as a consequence of pet ownership. Noncausal explanations might be more clearly seen as confounds, they are factors which might be associated with both pet-ownership and improved health. As such the association between health and pet-ownership is only due to this variable. Within this explanatory class can be considered factors which might be associated with both health benefits and pet ownership, such as personality, differential health of pet owners and socioeconomic status.

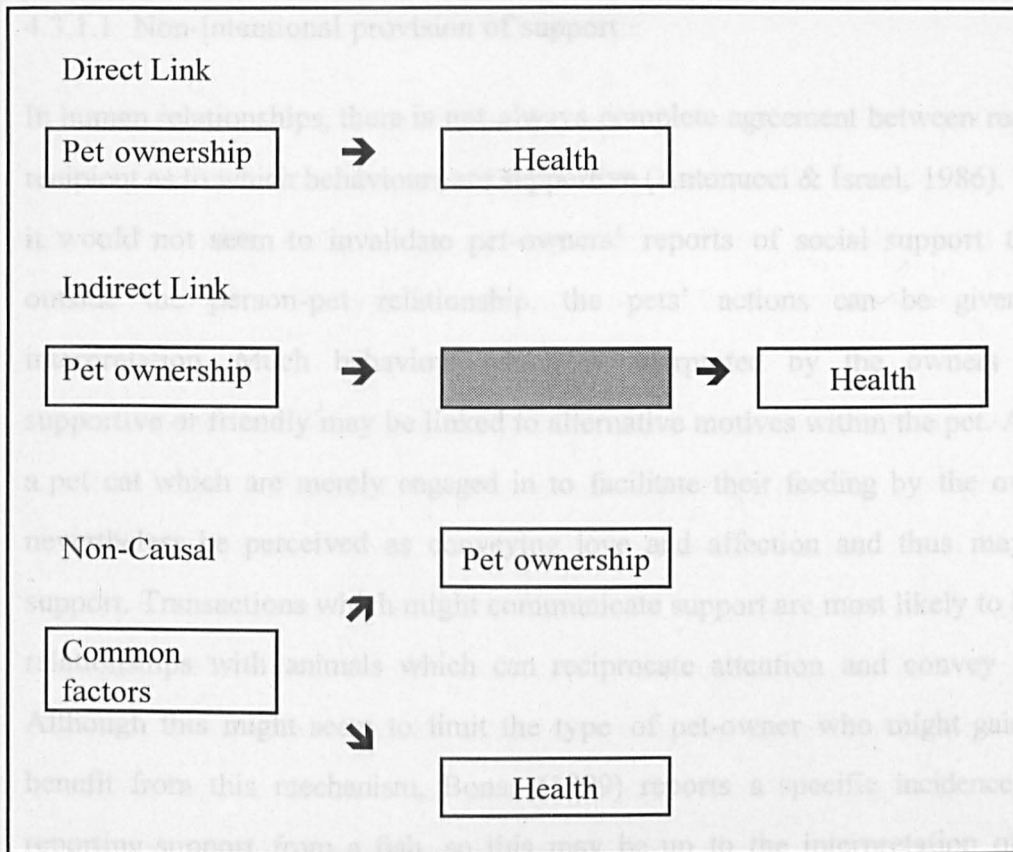


Figure 4.1 Tripartite model of explanations for the association between pet-ownership and advantages for human health. From McNicholas & Collis, 1998a p.175.

4.3.1 Pets as a source of social support

As human relationships have been recognised as an important influence on health, it is not surprising that one way in which person-pet relationships have been examined is using a social support framework similar to that used to characterise the benefits of human-human relationships. Examination of the aspects of human-human relationships which are considered to be supportive reveals many aspects which can be applied to person-pet relationships. However, there are certain limitations which need to be examined which might preclude a social support / companionship interpretation of the person-pet relationship. First, actions by the pet are unlikely to have any supportive intentions, should they nevertheless be considered supportive? Second, animal behaviours are non-verbal, so would this preclude their assessment as supportive? Third, can animals perform any behaviours which fall under the remit of a social support or companionship definition?

4.3.1.1 Non-intentional provision of support

In human relationships, there is not always complete agreement between receiver and recipient as to which behaviours are supportive (Antonucci & Israel, 1986). Therefore it would not seem to invalidate pet-owners' reports of social support that, from outside the person-pet relationship, the pets' actions can be given another interpretation. Much behaviour which is interpreted by the owners as being supportive or friendly may be linked to alternative motives within the pet. Actions by a pet cat which are merely engaged in to facilitate their feeding by the owner may nevertheless be perceived as conveying love and affection and thus may provide support. Transactions which might communicate support are most likely to be seen in relationships with animals which can reciprocate attention and convey emotions. Although this might seem to limit the type of pet-owner who might gain a health benefit from this mechanism, Bonas (1999) reports a specific incidence of a girl reporting support from a fish, so this may be up to the interpretation of the pet-owner.

4.3.1.2 Non-verbal provision of support

With social support in human relationships, there has been a move towards examining the types of communication which supply social support (e.g. Burleson, Albrecht, & Sarason, 1994b). In this sense, pets are limited to communication with non-verbal channels of communication (exceptions are talking birds, but these tend to be taught responses rather than unique communications). Although Cobb's (1976) definition emphasised social support as being *information*, this need not be communicated verbally. A number of writers include being present and listening as important aspects of human emotional and esteem support (Dakof & Taylor, 1990; Lehman & Hemphill, 1990; Tolsdorf, 1976).

4.3.1.3 Types of support provided by animals

The main aspect of social support to cope with a stressor that pets would seem to be able to provide is esteem support (cf. Cohen & Wills, 1985). As proposed by Cohen and Wills (1985), esteem support may combat threats to self-esteem posed by stressors and is thus likely to be useful against a wide range of stressors.

Pets are noted for their ability to provide unconditional love which could provide emotional support (Siegel, 1990). Pet-owners frequently describe their pets as loving them (Triebenbacher, Wilson, & Fuller, 1998; Zasloff & Kidd, 1994). One feature encompassed in measures of human emotional support is the ability to provide physical comfort (Orth-Gomér *et al.*, 1993). Although there may be many taboos in physical contact between adults, it has been noted that these do not apply as strongly to contact between animals and humans (Serpell, 1996). It is perfectly legitimate to stroke animals and to hug and cuddle them (Katcher, 1981).

There are a number of ways in which pets may increase their owners sense of self-esteem. Weiss (1974) has defined a relationship provision of nurturance or the ability to provide support to another individual. Mutual obligation also figures in the taxonomy of Cobb (1976). Looking after a pet and the sense of being needed by it may enhance self esteem.

Dogs have a natural tendency to assume a subordinate role to those they consider dominant in their pack and as such display many behaviours which can enhance their owners' self esteem. These behaviours include eagerness to please, attentiveness and willingness to co-operate as well as the desire to be in close proximity to their owner (Serpell, 1996). This proximity behaviour is especially demonstrated by dogs. Other species may not be as interactive as dogs, but many will have greeting behaviour which owners may interpret as gladness to see their owner and as such can enhance self esteem. Some owners may enhance their own self-concept by dominating their pets. A number of studies have found that self-esteem or self-concept is higher in

child pet-owners than in non-owners (Poresky, Hendrix, Mosier, & Samuleson, 1988; Vanhouette & Jarvis, 1995). However, Harker (1999) notes that an individual's self esteem may influence their likelihood to own a pet, as well as the degree to which they interact and bond with the animal

The normalising effects of interaction with pets may be important in enhancing self-esteem of people who have debilitating or disfiguring conditions or illnesses. Being treated normally has been reported as important in enhancing self-esteem in multiple sclerosis patients (Lehman & Hemphill, 1990). Animals, being relatively insensitive to physical disability, disfigurement, or social taboos surrounding illness may be a particularly helpful source of self-esteem for specific groups (e.g. AIDS patients Camack, 1991).

Although pets may provide a general enhancement of self esteem, they are unlikely to be able to provide esteem support specific to a stressor. This may limit their ability to reduce the effects of stress, as the matching hypothesis of Cutrona and Russell (1990) suggests that esteem support is best when matched to the requirements of the stressors and, in that case, has to be more tailored than just communication that '*you are a good person*' but rather '*you are a good person in this specific situation*'.

The studies of effects on bereavement (Akiyama *et al.*, 1986-87; Bolin, 1987) suggest that pets may have a stress buffering effect against these stressors, although the evidence is far from conclusive. These stressors involve a loss of social relationships and thus the relationships offered by pets might be expected to be particularly useful in matching the requirements of the person experiencing the stressor (cf. Cutrona & Russell, 1990), whereas pets might not be as useful against economic stressors, especially as they are an additional drain on financial resources.

The majority of studies which examine the relationship between pet-ownership and health do not examine stress levels, so it is impossible to assess whether the

participants are being buffered from stress or whether it is a general main effect on well being. Siegel (1990) found that dog-owners did not show the same increase in use of physician services with increasing levels of stress as non dog-owners evidenced. Bonas (1998) examined self-reported recent stress and both psychological and physical symptoms. Although complex, her results suggested that pets had a stress buffering effect on psychological symptoms, but there was no effect on physical symptoms.

Animals may also be able to provide a role in affect regulation. One feature of human relationships regarded as supplying emotional support is being there to be confided in (Dakof & Taylor, 1990; Lehman & Hemphill, 1990). Although pets cannot respond verbally to such confidences and offer advice, many pet-owners still confide in their pets and apparently gain comfort from doing so (Bonas, 1998). Pets have been likened to certain therapists who aim not to be directive (Beck & Katcher, 1996).

Pets may have a role in anger management (other than the kick the cat variety!). Pets may be as effective as a human listener, or passive medium such as paper or a tape recorder in enabling people to disclose their anger to an 'other' (Pennebaker, 1990). Volume of discussion of angry thoughts is seen as an important aspect of anger discussion (Thomas, 1997), as loud outbursts of discussion have been found to prolong physiological arousal and psychological anger (Siegman, 1994). Pets are not likely to react well to being shouted at during anger release, as they lack the ability to recognise that the anger is not directed towards them. Therefore 'discussion' with a pet may be more likely to occur in measured tones which, it has been suggested, are healthier (Friedmann *et al.*, 1980). Pets may also be able to diffuse anger in other ways, being seen as sources of humour, an impetus for exercise or distraction.

One of the main functions seen of pet relationships is their companionship. Siegel (1990) found that the majority of the benefits of pets reported by participants in her study were related to companionship and pets being a source of company. A

definition of companionship which was designed to cover human-human relationships from Rook (1990) emphasises the role of the companion as participating in shared leisure interests, purely pleasurable interaction, private jokes or rituals and playful and uncensored spontaneity. Pets can be seen to fulfil many of these functions. Pets may be particularly helpful in that they do not condemn their owners for any behaviour. By encouraging their owners to relax without focusing on stressful situations, pets may fulfil aspects of distraction which has indirect stress reducing effects.

Limitations of pets to provide aspects of social support may occur in the realms of information and instrumental support. Informational support or guidance would appear to be impossible for pets to provide due to its intrinsic verbal component. Although some pets may provide instrumental support in providing a security function for their owners which may reduce their worries about protection of personal assets this would seem to be limited to certain species and breeds of animal. Service animals may provide valuable practical assistance and independence to their owners which may in turn have benefits in increasing self-esteem (cf. Allen & Blascovich, 1996).

4.3.1.4 Additional advantages of mobilising support from pets

The acquisition of one more human friend is unlikely to have a measurable effect on health in those with adequate other relationships (Cohen & Wills, 1985). Therefore if people have adequate human social relationships, why should there be any advantages to having a pet?

Pets may provide an extra something missing in human relationships. Weiss (1974) suggests that a variety of social relationships are required to fulfil a range of relational provisions and that the absence of a required type of relationship provision can promote distress. It is possible that relationships with pets can fill some relational

provisions which might be absent in existing human relationships. Pets are less likely to be a source of conflict than human relationships (Bonas, 1998). One of the most beneficial aspects of person-pet relationships is that they are not fraught with the same reciprocal nature as human-human relationships. Mobilisation of human social support can be associated with costs as well as benefits. DiMatteo and Hays (1981) suggest that the receipt of social support may actually undermine a person's self-esteem as it labels them as an impaired person relative to the support provider. The seeking of social support has two negative sides: first, it may make the receiver feel indebted to the provider; and secondly it may require the receiver to disclose their inability to deal with a problem in order to mobilise that support.

These costs may limit people in seeking social support from their human networks, but presumably they would not feel the same inhibitions about turning to their pet for support. The provision of social support by pets is not associated with any reciprocal requirement to provide support or to have appeared inadequate. In addition, pets, being silent, cannot pass on information regarding moments of weakness to others.

Support offered by pets, in that it is silent, may not be as likely to be misconstrued as support attempts from humans. It is easy for verbal messages intended to be supportive to be interpreted as unsupportive (Albrecht & Adelman, 1987; Goldsmith, 1994). In contrast, whilst being silent may be misinterpreted in human companions as not conveying support, there is no expectation that pets will make a supportive, comforting comment, so their silence is also not available for misinterpretation.

An obvious advantage of pets is that they can be gained fairly easily. Although it may be difficult to establish a supportive relationship with another human, it is easy to purchase a pet and the majority of people can enjoy a mutually satisfying relationship with their pet. Pets may be an important social resource for members of society who for reasons such as age, homelessness and social stigma of illness have impoverished

human social networks. In humans, main effects of social support are expected to be most visible when contrasting social isolates and people with moderate or high human social support (Cohen & Wills, 1985). Thus it is most likely that health benefits of pet-ownership, if they exist, will be seen in people with a low levels of human support or where human support is deficient in a certain area in which the pet compensates. This suggestion is supported by the study of Goldmeier (1986) which found health benefits associated with pet relationships only in people with lower human support, as indexed by fewer confidants.

4.3.1.5 Conclusion - can pets provide social support?

In conclusion, it seems plausible that pets can convey emotional and esteem support, companionship and in some cases instrumental support to those humans with whom they interact. Although the concept of social support was initially developed to describe the positive interactions between members of the *same* species (Cassel, 1976), in many aspects human-companion animal relationships can be seen to provide similar support as human-human relationships, even if only in the perception of the pet-owner. As support from a pet is primarily due to the owners' perception, it may be less vulnerable to being misconstrued as unsupportive. Interaction with pets is limited to non-verbal communication, however, this may also have some advantages over social support provided by humans in that it has fewer costs in terms of revealing weakness and requiring reciprocity.

4.3.2 Promotion of healthful behaviours

Promotion of healthful behaviours, both generally and when things become stressful, is regarded as one of the health promoting aspects of human relationships (Meier, 1982; Umberson, 1987). Could this generalise to human-companion animal relationships? Social control is presumed to operate on two levels: indirectly as a motivation to look after oneself as a consequence of responsibilities for others and directly through cues to behaviour, physical intervention and sanctions (Umberson,

1987). It is unlikely that pets can impose sanctions on their owners for unhealthy behaviours such as smoking or drinking. However a perceived responsibility to a pet may promote more healthful behaviours. As yet there is no empirical evidence to support this suggestion. Although anecdotally, pets have been reported to be an impetus to keep the house warm and to engage in regular feeding. Staats, Pierfelice, Kim and Crandell (1999) report support for a model which relates human self care to self care of a pet, although no causal pathway can be assumed.

4.3.3 Exercise

Health behaviours generally do not seem to consistently differentiate pet-owners and non-owners in either a healthful or unhealthy direction (Anderson *et al.*, 1992; McNicholas & Collis, 1998a; McNicholas & Collis, 1998b). However an exception to this generality is exercise, which has consistently been shown to be higher in dog-owners than other groups of pet-owners and owners than non-owners (Anderson *et al.*, 1992; McNicholas & Collis, 1998b; Serpell, 1991). Despite being referred to as a possible confound in some studies examining pet-ownership and health (e.g. Anderson *et al.*, 1992; Serpell, 1990), it is not credited with being the main reason underlying any effects seen.

The lack of attention given to an exercise explanation seems foolish given the well established beneficial impact of vigorous intensity exercise on health (Blair, 1992; Fletcher *et al.*, 1996). Empirical studies have also documented the benefits of regular low intensity activity such as walking 1-2 miles per day in reducing mortality risk (Hakim *et al.*, 1998; Paffenbarger *et al.*, 1993). Walking has been shown to have a beneficial impact on blood pressure (Ohta *et al.*, 1990), blood lipid profiles (Duncan, Gordon, & Scott, 1991) and cardiovascular fitness (Hamdorf, Withers, Penhall, & Haslam, 1992). More recently, evidence has been collated which also suggests that exercise may have measurable psychological health benefits (Scully, Kremer, Meade, Graham, & Dudgeon, 1998).

Exercise promotion programmes have recognised the value of walking dogs as a source of exercise. Additionally, the evident motivation of a dog wanting exercise may encourage the dog-owner to walk. Therefore, the exercise gained in walking dogs may well explain the more favourable cardiovascular risk factor profile for pet owners identified by Anderson *et al.* (1992), the survival status advantages reported by Friedmann and Thomas (1995) which were only seen in dog owners, the benefits on health service utilisation only seen in dog owners (Siegel, 1990) and the improvements in physical and psychological well-being seen in people newly acquiring a dog which are not as strong or long lasting in cat owners (Serpell, 1991). Health benefits seen in other studies of pet owners which do not differentiate pet type may be due to the contribution of dog owners in the general pet owning population: Approximately 70% of pet owners studied have dogs.

As a guard against the 'exercise effect', some studies have contrasted dog-owners with owners of other species; with the assumption that health benefits derived from exercise will not be seen in owners of pets other than dogs. Although ownership of other species may also involve some increased exercise, e.g. horse riding, owners of these species are a small proportion of the pet owning population. The two studies which use this strategy (Anderson *et al.*, 1992; Friedmann *et al.*, 1980) report similar effects for dog-owners and owners of other species and thus discount this possibility. However, in contrast to their analyses which demonstrated the overall benefits of pets, which take into account age and sex differences, their refutation of the exercise explanation is based on univariate comparisons which leaves open the suggestion that the univariate results are due to a combination of other factors.

Appropriately contrasting owners of species which do and do not require owner involved exercise seems the best way to address the exercise explanation. However this ignores the differences in relationship which people report with different species of pet. Dog-owners tend to report substantially closer, supportive relationships with their pets than owners of other species (Bonas, 1998; MacCallum *et al.*, 1992).

Therefore if closeness of the relationship was the key, this would be very difficult to separate from exercise effects.

4.3.4 Direct physiological effects

The strongest evidence for a link between health and pet-ownership is in the realm of cardiovascular health. This has led to a particular examination of the effects that pets might have which might be related to cardiovascular health. There are three abilities usually attributed to animals; a) animals are able to moderate the stress responses of people they are with; b) watching animals produces reductions in blood pressure and c) stroking or petting animals reduces blood pressure. These effects are taken as established in articles which purport to review the evidence in both scientific (e.g. Beck & Meyers, 1996; Brasic, 1999; Edney, 1995) and lay press (e.g. Browne, 1996; Hay, 1996). Given the appeal of this explanation to both the lay and scientific community, it is worth evaluating the evidence that supports these claims.

Evidence that stroking pets can produce short term changes in blood pressure is frequently cited. To support this claim, it would need to be shown that a period of rest with a pet produces cardiovascular levels which are lower than those seen when resting without a pet - otherwise there is no advantage to being with a pet. A summary of studies investigating this issue is shown in Table 4.1. A verdict was drawn on the ability of these studies to detect lower cardiovascular levels whilst the person was petting an animal compared to resting quietly with no animal. This verdict was based on four criteria; a) sample size reasonably able (80% power) to detect a large sized ($d=.8$) difference in blood pressure levels between conditions; b) allowing a period of at least 5 minutes acclimatisation prior experimental conditions; c) balancing the order of the experimental conditions to avoid capitalising on order effects, d) providing resting and petting conditions for comparison.

Table 4.1 Design features of studies which investigate the claim that stroking pets can produce short term changes in blood pressure or heart rate.

Study	Human participants	Acclimatisation period	Condition order	Experimental conditions
Katcher (1981)	N=35, sex ?, age ?	no	invariant, petting last	<ul style="list-style-type: none"> • rest, • reading aloud • petting own dog
Baun <i>et al.</i> (1984)	N=24, m/f, age 24-74 y, mean 46.7 y	10 minutes	balanced	<ul style="list-style-type: none"> • reading quietly • petting own dog • petting unfamiliar dog
Grossberg & Alf (1985)	N=48, m/f, age ?	10 minutes	balanced	<ul style="list-style-type: none"> • rest • petting dog • casual conversation • reading aloud
Jenkins (1986)	N=20, m/f, age 9-58 y, mean 29.8 y	18 minutes	balanced	<ul style="list-style-type: none"> • reading aloud • petting dog
Wilson (1987)	N=92, m/f, age 18-39, mean 23.2 y	10 minutes	balanced	<ul style="list-style-type: none"> • reading quietly • reading aloud • petting dog
Vormbrock & Grossberg (1988)	N=60, m/f, age 18-24 y	20 minutes	balanced	<ul style="list-style-type: none"> • rest • petting dog • petting and talking to dog • talking to dog • talking to person with dog present • talking to person no dog
Eddy (1995)	N=10, sex? age 20-31 y	1 measurement	invariant, petting last	<ul style="list-style-type: none"> • rest • watching chimps • petting chimps
Eddy (1996)	N=1, m, age?	2 minutes	invariant, petting last	<ul style="list-style-type: none"> • rest • watching snake • petting snake
Hama, Yogo, Matsuyama (1996)	N=18, m, age?	10 minutes	invariant	<ul style="list-style-type: none"> • petting horse ²
Alonso (1999)	N=5, m/f, 18-35 years	2 minutes	invariant, petting last	<ul style="list-style-type: none"> • rest • watching snake • petting snake

Note. The order in which conditions listed is the same as the order in the experiment, unless balanced order indicated. Shaded cells indicate where studies fail criteria of a) adequate sample size, b) adequate acclimatisation period, c) balanced order of experimental conditions or d) design including a resting and petting condition. ? = indicates information not provided in published report.

² Hama, Yogo & Matsuyama (1996) was designed to investigate changes in heart rate whilst petting a horse in participants with differing attitudes towards horses. They do not include a resting condition, although visual examination of graphs shows that levels throughout the petting stage are higher than those measured during the baseline stage.

By these considerations, the studies of Jenkins (1986), Katcher (1981), Hama, Yogo, and Matsuyama (1996), Eddy (1995; 1996) and Alonso (1999) can be rejected as their designs do not meet all the criteria. Conclusions cannot reliably be drawn from studies which do not meet these criteria, as either the power of the study is inadequate to detect any effect even if present, a short acclimatisation period means that cardiovascular levels are likely to still be decreasing over the experimental session and when condition order is invariant this capitalises on the lowest levels being seen in the last presented condition, and evidence that petting animals is relaxing cannot be gained from a comparison with a known stressor such as reading aloud.

Of the four well designed studies, none show statistically lower levels when petting a dog compared to resting quietly without a dog: Baun *et al.* (1984) found blood pressure levels were *higher when petting the dog* compared to reading quietly, although no statistical comparisons were reported; Vormbrock and Grossberg (1988) found that levels *did not differ significantly* between the conditions of resting without a pet dog and stroking a pet; Wilson (1987) found levels were *significantly higher when petting the dog* compared to reading quietly without the dog present; and Grossberg and Alf (1985) also found participants to have *significantly higher cardiovascular activity when stroking the dog* than when resting quietly without the animal present. Given the power of some of these studies to detect even the smallest effects, it could reasonably be concluded that they provide convincing evidence that *stroking a pet produces acute increases in blood pressure*. However, there is no evidence to support the oft cited suggestion that stroking a pet will produce *reductions* in blood pressure.

Evidence that watching pets is associated with acute blood pressure changes is equally unconvincing. DeSchriver and Riddick (1990), report no significant differences in either changes in blood pressure or muscle tension in response to watching fish in an aquarium as opposed to watching a video tape of TV static. Katcher, Friedmann, Beck and Lynch (1983) report that blood pressures were lower when people watched fish in an aquarium as opposed to staring at a blank wall, although they do not provide

statistical tests and note that watching the wall was aversive to participants. Therefore neither of these studies convincingly demonstrates lower blood pressures when watching natural scenes than other restful activities.

Given the absence of relaxing short term effects of either watching or stroking animals on blood pressure or heart rate these authors would need to explain how and why long term health benefits would be produced.

A third possible physiological effect of animals is their ability to moderate stress responses of humans they are with. Friedmann (1995) has suggested that the effects of animal moderation of stress might not be limited to their owners, and thus the presence of animals may have benefits for all with whom they interact. Reductions in cardiovascular reactivity from the presence of ones pet might be considered as a mechanism underlying health benefits of companion animals in a similar manner to that proposed for effects of human friends. Kamarck *et al.* (1990) suggested that regular moderation of the stress response from the presence of supportive friends might have long term health benefits. It should be noted that the first studies to examine the stress moderation effects of companion animals (Friedmann *et al.*, 1983b; Grossberg, Alf, & Vormbrock, 1988; Locker, 1985) actually pre-date the suggestions of Kamarck (1990). Given the increasing evidence that presence of human companions can moderate stress responses, and the accepted linking of this mechanism to the established health benefits of human companionship (Uchino *et al.*, 1996), this line of research might reveal a mechanism through which the health benefits of animals might occur. The evidence relating to the ability of companion animals to provide such stress moderation is considered in Chapter 5 and the further exploration of this mechanism provides the substance for the rest of this thesis.

4.3.5 Pets as social facilitators

It has been suggested that the association between pets and health could be via

increasing the interaction between other humans and thus increasing the human social support network (Collis, McNicholas, & Harker, unpublished).

A number of studies have demonstrated a robust '*social catalysis*' where people with pets, especially dogs, engage in more conversations than those unaccompanied by animals. This effect has been found between a variety of types of people and in various settings (Eddy, Hart, & Boltz, 1988; Hart, Hart, & Bergin, 1987; Hart, Zasloff, & Benfatto, 1996; McNicholas & Collis, unpublished; Messent, 1985). It is possible that people who engage the pet-owner in conversation may go on to become either friends or acquaintances whom the pet-owner can rely upon for social support. However, as yet this suggestion has not been substantiated. A recent study by Collis, McNicholas and Harker (unpublished) suggests that dog-owners on average report 11% of their social networks are people met in some manner through their dogs, but these relationships remain at acquaintance levels and do not provide social support. If the pet led to the addition of an important confidante to the social network, then this might be expected to affect health; whereas, the addition of a few acquaintances might only be expected to have a demonstrable effects for socially isolated individuals.

In addition, although the social facilitation effect might be seen for any pet animal (cf. Hunt, Hart, & Gomulkiewicz, 1992). In reality, it is only likely be seen for dog-owners or owners of other animals which require the owner to accompany their exercise. Animals which exercise independently (e.g. cats) or do not require exercise (e.g. snake) would not be expected to produce such an effect. However as noted with the exercise explanation, as dog-owners constitute such a large proportion of the pet owning population, this effect may be an important confound.

4.3.6 Personality traits

A variety of studies have investigated whether there are personality differences between pet-owners and non-owners. As discussed in Chapter 2, a number of

personality factors may moderate the links between stress and illness. If differences in these personality traits are independently associated with both a tendency to own pets and a reduced impact of stress on health, then this might provide a non-causal explanation for the association of pet-ownership and health, presuming that the personality differences pre-date the pet-ownership status.

Trait measures of personality are presumed to be stable constructs. Therefore if an association is found between pet-ownership and a personality trait, it is unlikely that the ownership of a pet produced changes in personality, and more likely that the personality trait influences the propensity to own a pet. However, this cannot be fully evaluated without longitudinal studies. The available cross-sectional studies suggest that pet-ownership is not associated with personality differences likely to affect health.

Watson and Weinstein (Watson & Weinstein, 1993) found no differences in trait anxiety (Spielberger, 1983) or anger (Spielberger, 1988) between pet-owner and non-owner groups. Owners' attachment to their pet was also not correlated with these personality measures. Straede and Gates (1993) found no differences in trait anxiety (Spielberger, 1983) between cat-owners and non-pet-owners. Friedmann *et al.* (1983b) report no differences in the personality constructs of tension, anxiety, depression, confusion, vigour or fatigue in their sample.

More recent research has focused on personality variables explicitly expected to be related to cardiovascular health and or susceptibility to stress such as Type A personality (McNicholas & Collis, 1998a) and the hardy personality (McNicholas & Collis, 1998b). In both studies there was the suggestion that pet 'people' score more highly in the direction likely to indicate *increased* susceptibility to stress. For example in the hardiness study (McNicholas & Collis, 1998b), those who reported household pets as theirs specifically scored lower than those who just lived in a household with a pet. In the Type A study (McNicholas & Collis, 1998a), ownership groups of 'cat or

dog' or 'other species' had higher scores than people who owned no pets. McNicholas and Collis were not able to differentiate a component which might represent the 'hostility' component of Type A personality (cf. Siegman & Dembroski, 1989), but examination of specific items did not suggest that the hostility items differentiate pet-owners and non-owners.

4.3.7 Differential health of pet-owners and non-owners

A number of studies have addressed the possibility that the association between health benefits and pet-ownership might occur because healthier people are more likely to own pets. Friedmann *et al.* (1980) examined whether in her study the heart attack victims with pets might have had less heart damage. However, the association between pet-ownership and increased survival levels remained after controlling for this possible confound. In the CAST trial, physiological severity was also found not to account for the association between pet-ownership and improved survival (Friedmann & Thomas, 1995). Serpell (1991) found no difference in reporting of minor physical or psychological health problems in people choosing to own a cat or dog at the start of his study, although these had changed to reflect better health in both cat and dog-owners one month later, a change which was not seen in a control group. Thus although the evidence is not incontrovertible, it would seem that pet-owners are not intrinsically healthier than those who choose not to own a pet.

In fact, Anderson *et al.* (1992) report that the Australian pet-owners in their sample had greater consumption of meat, alcohol and take-away food than non-owners, which could make them less healthy, although they were more active. McNicholas and Collis (1998a) also report higher levels of smoking in their pet-owner groups than in non-owners but no differences on alcohol consumption. Another of their studies (McNicholas & Collis, 1998b) found no differences in smoking and alcohol drinking behaviours between pet-owners and non-owners, although they did report that dog-owners take more exercise. Serpell (1991) documents the increase in exercise which

accompanies the acquisition of a dog. Thus, with the possible exception of exercising, pet owners do not appear to engage in habits which should make them healthier either.

4.3.8 Socio-economic factors

Pet-ownership requires a degree of financial solvency to buy food, and pay health care bills. As keeping a pet is not an essential, it is likely that pet-owners have a degree of disposable income they wish to spend in this way. Pets are more likely to occur in detached houses (Rost & Hartmann, 1994; Siegel, 1995; Wells & Hepper, 1997) and in nuclear families more than single parent families (Kidd & Kidd, 1989). These factors suggest that pet-owners are likely to be wealthier than non-owners and to have a greater disposable income. The studies of Covert, Whiren, Keith and Nelson (1985) and Siegal (1995) confirm that pets are more frequently found higher income US families. A survey of 1478 Dutch households found that there were significantly more pet-owners in their highest income category and more non-owners in the lowest income category (Endenberg, Hart, & Vries, 1991). The Pedigree Pet Foods Survey (Pedigree Pet Foods, 1996) of UK Households suggests that pet ownership is more prevalent in social class category 'C2' - skilled working class, with fewest pets owned in their lowest social class category 'DE' - semi or unskilled manual workers and subsistence households.

If income or socioeconomic status differences exist between pet-owners and non-owners, it could explain why pet-owners are healthier. Socioeconomic status has been linked to health in a number of studies where it has been found that people in higher socioeconomic groups are healthier and live longer (Carroll, Davey Smith, & Bennett, 1996; Marmot *et al.*, 1991).

Anderson *et al.* (1992) did examine socioeconomic status in their study and found similar levels between owner and non-owners. However as noted, their pet owning sample may not have been representative of the Australian pet owning population.

The majority of studies on pet ownership and health do not examine this potentially important confound so its effect is largely unknown.

4.4 Conclusions

A number of studies suggest that pet-owners may enjoy psychological and physical health benefits. Explanations which derive from the nature of the relationship between owner and pet can be subsumed under social support and social control mechanisms which are originally applied to the human-human social relationships. Pets would seem to be able to fulfil both of these roles and therefore that benefits derive from pet relationships in the same way as human relationships cannot be discounted. However there are at least three important confounds which might account for the health benefits of pet owners and which do not necessarily derive from the relationship. First, pet owners may exercise more frequently than non-owners. Second, pet owners may increase the number of human relationships via activities involving their pets. Third, pet ownership may be associated with higher socioeconomic status. An important aspect of each of these confound explanations is that these effects are confined to, or stronger in dog owners than owners of other species who do not require any / as much exercise, do not lead to interactions with other people or which are concentrated in lower income households. However, the nature of the relationship with dogs is consistently reported as closer than with these other species, therefore it seems that the two competing sets of explanation are impossible to disentangle. These explanations are not necessarily mutually exclusive, and may operate together.

One of the most intriguing mechanisms which has been proposed for this effect is that animals have direct physiological effects on the humans with whom they interact. The next chapter provides a critical overview of the studies examining physiological effects of animals on humans.

Chapter Five

Studies on the effects of companion animals on the human cardiovascular system

5.1 Introduction

As discussed in Chapter 4, in a number of empirical studies, pet ownership has been associated with increased well-being. Particularly of note, although not incontrovertible, are the associations with cardiovascular well-being. One potential mechanism which might account for these findings was discussed in Section 4.3.4, that of companion animals moderating the cardiovascular reactivity of their owners. This suggestion has been linked with the cardiovascular reactivity hypothesis (Krantz & Manuck, 1984) which suggests that people who react more strongly to stressors will be at greater risk for cardiovascular complications. Parallels can also be drawn between the effect of a companion animal and the proposed effects of the presence of a close or supportive human companion moderating cardiovascular reactivity, as reviewed in Section 3.3. The following chapter provides a critical overview of available research on the effects of animals on human cardiovascular reactivity.

5.2 Review of studies

The first paper in this genre was that of Friedmann, Katcher, Thomas, Lynch, and Messent (1983b). This paper was an attempt to examine some of the mechanisms which might account for the cardiovascular health benefits which were seen in the pet owners in Friedmann *et al.*'s classic 1980 study and the success of using animals in psychotherapy. Friedmann *et al.* proposed that reduction of the stress response might lead to just such benefits.

Friedmann *et al.* tested 38 children using a within-subjects exposure to the dog. The dog was either introduced or removed half way through the session. In each half of the experiment, the child was asked to sit for two minutes and then read aloud for two minutes. Friedmann *et al.* found that blood pressure levels, in both baseline and task phases of the experiment, were significantly lower when the dog was present. However there was no effect of the dog on heart rate levels. A second aspect of the analysis was to see whether the presence of the dog affected participant's reactivity to the task. A significant interaction between Phase (baseline, task) and Condition (dog present, absent) would indicate differences in reactivity to the reading task depending on whether the dog was present or absent. However, in Friedmann *et al.*'s study this was non-significant for all variables, therefore there was no effect of the dog's presence on reactivity.

Friedmann *et al.*'s study demonstrated a significant main effect of the presence of a companion animal on cardiovascular activity. However, their discussion does not reflect the statistical findings and this has led to misinterpretation of the results of the study. Given the importance of this study in establishing in the public and scientific press that pets can reduce their owners reactivity to stress, these misinterpretations deserve further scrutiny. There are three issues of concern, a) apparent presentation errors in the figures in the ANOVA table, b) misreporting of which cardiovascular variables were affected and c) misinterpretation of the statistical effects in the analysis.

Friedmann *et al.*'s presentation of their statistics seem to be inaccurate. The figures for diastolic blood pressure and heart rate are very similar suggesting some form of transposition or other reporting error. This was highlighted in an article published in 1988 (Grossberg, Alf & Vormbrock) however, there has never been a published response to this assertion by Friedmann or colleagues.

Although Friedmann *et al.*'s results were significant only with respect to blood

pressure, their discussion refers to an effect on 'lowered BP and HR' (1983b p.464). The effect on heart rate was far from significant ($p=.49$) but the error influenced subsequent authors interpretation of the results. Grossberg, Alf and Vormbrock (1988 p.38) state that Friedmann *et al.*'s (1983b) experiment 'showed that BP and HR were significantly lower during dog present trials'.

The most serious misinterpretation in Friedmann's *et al.*'s (1983b) study concerns the distinction between reactivity and main effects. To illustrate this issue, two examples of the pattern of results which might be seen in a reactivity study are given in Figure 5.1. For ease of explanation, situations will be described where the intervention moderates cardiovascular activity or reactivity, although obviously the converse might occur, the intervention in this case being presence of a companion animal.

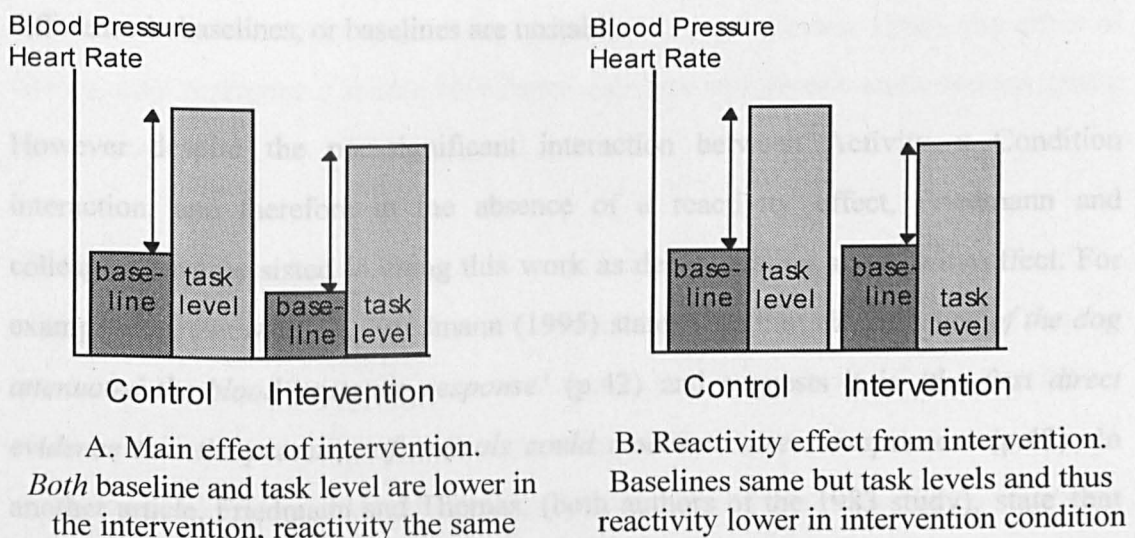


Figure 5.1 Patterns of effects in reactivity studies.

A main effect of companion animal presence would be shown if both baseline and task levels were significantly lower when an animal was present compared to when there was no animal present. An example of this type of effect is shown in scenario 'A'. In this situation, both baseline and task levels are lower for the intervention group, although there is no difference in reactivity. This type of result would indicate that the presence of the dog was reducing cardiovascular activity throughout the experiment (in

between-subjects designs, it might indicate that there were differences between the two groups from the start of the experiment). This is the type of effect that Friedmann *et al.* found on blood pressure.

The type of effect that Friedmann *et al.* were looking for was an effect on reactivity, as moderation of reactivity has been proposed to have health benefits. A reactivity effect would be shown by a significant interaction between resting and task periods and experimental condition (either dog present or dog absent). In scenario 'B', there is a difference in reactivity but the baselines of the two groups are the same. This would imply a genuine effect of condition on reactivity. There may be various patterns of differences in baselines, task levels and reactivity which might all produce a statistically significant interaction between condition and rest-task levels, but a conclusion that the condition has affected the reactivity is uncertain while there is a difference in baselines, or baselines are unstable.

However despite the non-significant interaction between Activity x Condition interaction, and therefore in the absence of a reactivity effect, Friedmann and colleagues have persisted in citing this work as demonstrating a reactivity effect. For example in a review article, Friedmann (1995) states that the '*the presence of the dog attenuated the blood pressure response*' (p.42) and suggests it is '*the first direct evidence that the presence of animals could moderate stress responses*' (p.43). In another article, Friedmann and Thomas, (both authors of the 1983 study), state that their 1983 study '*has documented that the presence of a pet is associated with decreased cardiovascular reactivity to stressors*' (1995 p.1213). This clearly suggests that the effect of the dog was on reactivity and therefore erroneously links it to the cardiovascular reactivity hypothesis (Krantz & Manuck, 1984).

Another misinterpretation of the statistics is when Friedmann *et al.* (1983b) suggest that the effect of the dog was greater when it was shown in the first half of the experiment than the second. They derive this hypothesis from the significant Group

(dog first, second) by Condition (dog absent, present) interaction. In fact, in their analysis, this interaction is equivalent to a comparison of the cardiovascular levels in first and second halves of the experiment. The analysis actually demonstrates that the levels were higher in the first half the experiment (baseline and task levels combined) than in the second half, an effect which might be expected, as cardiovascular levels often decrease over the first 15 minutes or so of measurements, and this entire experiment lasted only 10 minutes.

This confusion may have arisen, as the cardiovascular levels of the participants who saw the dog first were, on average, significantly lower than those who saw the dog second. However, Friedmann *et al.* do not report whether the order groups were balanced for sex or age of the participant, or how children were assigned to the two different groups. As both age and gender in children have been shown to affect baseline levels and reactivity (Murphy, Alpert, Willey, & Somes, 1988), the effect of Group, may represent a failure to balance experimental groups and resultant group differences.

Given the quality of the interpretation and reporting of this study, it might be expected that it would have been discounted by other researchers in the area as unsound. However, this study is one of the most cited for evidence of stress buffering effects of companion animals. Although an unfamiliar dog was used, these supposed effects have been generalised to pet owners who would presumably be present with their own dog. The effect of an unfamiliar dog might generalise to the person's own dog, however this is not certain and thus extension of these results represents an over interpretation. A second over interpretation can be seen as the results of this study have been generalised to all age populations and few commentators note that the study used child participants. Again, results from children may generalise to adults, but equally there may be specific processes occurring in children which do not generalise to adults.

The next study to look at the effect of presence of a companion animal on cardiovascular variables was a doctoral thesis by Locker (1985). Locker (p.121) proposed that stress moderation would occur because social support is a moderator of stress and the person-pet relationship could be considered a source of support. This was the first study to explicitly propose a role for social support, however, in her experiment, Locker used an unfamiliar dog with whom the participants had no prior relationship.

Locker's results provided some replication for the Friedman *et al.* (1983b) study in that she also found a general reduction in cardiovascular activity when the dog was present compared to when it was absent (scenario A). However, the effect was significant for heart rate not blood pressure and was only apparent when univariate analyses were examined. Locker initially used a MANOVA to analyse her results and found no overall effect of condition, therefore her examination of univariate effects in the absence of the main effect would appear to be an unjustifiable post hoc decision. Similarly to Friedmann *et al.*, Locker found no reactivity effects.

Locker attributed her results to the dog being a focus of attention for her participants. In accounting for the effect on heart rate and not blood pressure, she suggested that, although there might have been a tendency for the participants to focus on the dog, the degree of attention was only sufficient to reduce heart rate which is more sensitive to external stimuli and not blood pressure which takes longer to register a change. Locker suggested that the children in Friedmann *et al.*'s (1983b) experiment might have been paying more attention to their environment than the college students used in her study.

In contrast to the studies of Friedmann *et al.* (1983b) and Locker (1985) which used animals unfamiliar to the participants, the study by Grossberg *et al.*, (1988) was the first study to use the participant's own pet. However, the use of the participant's own pet raised issues concerning the nature of the experimental design. Friedmann *et*

al. and Locker both used a within-subjects design, where the animal was either removed or introduced half way through the experiment. However, Grossberg *et al.* reasoned that removal of the participant's own dog might cause emotional arousal which would interfere with any subtle differences in reactivity. Therefore Grossberg tested half of the participants with their dogs present and half alone.

The studies by Friedmann *et al.*, (1983b) and Locker (1985) had suggested that the presence of a companion animal produces a main effect reduction on cardiovascular variables. Detection of this type of effect, needs consideration of both baseline and task levels. However, Grossberg *et al.*'s (1988) analysis treated baseline levels, and the reactivity and recovery values for the four tasks, as nine within-subject dependent variables. The analysis was appropriate for the detection of reactivity effects, but it was not possible to determine whether there was a main effect of dog's presence on any cardiovascular variable. Grossberg *et al.* report no significant differences in any of their dependent variables by dog condition. Thus, a third study failed to find differences in reactivity dependent on the presence of a dog.

Grossberg *et al.* (1988) discuss this failure as possibly being due to their between-subjects design, small sample size or use of a normotensive population which might not demonstrate an effect of stress reduction as their responses are close to a floor level. Friedmann (1995) has also suggested the lack of effect might be due to pet owners with their pets present being worried about how well their pets would behave.

Given the concerns regarding testing dog owners with their own dogs in laboratory conditions, the study of Allen, Blascovich, Tomaka and Kelsey (1991) represents a sophisticated solution. Allen *et al.* tested their participants twice, the first session in a laboratory under controlled conditions and the second session in the participant's own home. The laboratory conditions for all participants were the same, just the experimenter present. However in the home setting, one third were tested with just the experimenter present, one third with the experimenter and their pet dog and one

third with the experimenter and their friend.

The first session established that there were no effects on cardiovascular activity or reactivity of groups in the laboratory setting before different treatments were introduced in the home setting. However, when subsequently tested in the home, there were differences in the reactivity of the three groups. Planned contrasts showed that participants in the pet condition had significantly lower reactivity than the alone condition, and the alone condition had significantly lower reactivity than when the friend was present. This effect was significant only for skin conductance and systolic blood pressure, not diastolic blood pressure or heart rate. Allen *et al.*'s analysis also demonstrated a main effect of dogs presence, however this was due to the reactivity effects and not due to differences in baseline levels.

Allen *et al.* concluded that the presence of the dog had acted as a source of social support for its owner and that this had reduced reactivity in an analogous manner to that seen in human reactivity experiments (Kamarck *et al.*, 1990). This therefore provides a link between the health benefits suggested to derive from social moderation of reactivity and health benefits of pet ownership. However, before accepting this as an explanation, it is worth examining other more plausible explanations.

Allen *et al.* (1991) noted that the participants in the friend condition appeared to speak more quickly than the participants in the other two conditions, although they did not systematically monitor this aspect of the experiment. However they discount this as potentially accounting for the reactivity differences as they cite references (Henderson, Bakal, & Dunn, 1990; Kelsey, 1991; Linden, 1987) which they say suggest that speech rate does not affect reactivity. Kelsey (1991) is a conference presentation and was not able to be examined. However scrutiny of the Henderson and Linden references suggests that they do not support Allen *et al.*'s argument.

Linden's (1987) study was of effects on cardiovascular reactivity of subvocal and

vocal speech and of variations in the personal relevance of speech topics. It did not examine differences in rates of speech. Henderson, Bakal and Dunn (1990) was a study of air traffic controllers and examined effects of formality and responsibility of speech on reactivity. This study also did not contain a comparison of speech rates, or even a measure of speech rate such as words spoken per minute. Given that neither of these studies examines the effects of rate of speech on reactivity, it is difficult to see how they can provide support for an argument that the effects of rate of speech on reactivity are minimal.

It is however notable that in their introductions, both studies (Henderson *et al.*, 1990; Linden, 1987) mention a study by Friedmann, Thomas, Kulick-Cuiffo, Lynch and Suginochara (1982) which compared effects of rapid and normal tempo speech on cardiovascular reactivity. This study (Friedmann *et al.*, 1982) found that reading at maximal tempo produced significantly greater systolic blood pressure reactivity than reading at normal tempo and number of words read per minute correlated significantly with MAP, SBP and DBP increases. Allen *et al.* do not refer to this study in their paper (Allen *et al.*, 1991), but it seems to refute their argument of discounting speech rate as a relevant issue. Another study published after Allen *et al.*'s study also found that decreasing the rate of speech led to reduced cardiovascular reactivity (Siegman, Dembroski, & Crump, 1992). Speech differences may therefore account for the results in Allen *et al.*'s study, especially if people moderate their vocal characteristics in the presence of their pet, as has been suggested by Katcher (1985). This is an issue which needs clarification in future studies.

Regardless of the mechanisms which might underlie the reactivity effects, the study of Allen *et al.* (1991) remains the only published study which suggests that presence of a companion animal reduces cardiovascular reactivity. Further unpublished experiments from Karen Allen's research group (Allen, 1998) seem to replicate the earlier findings but it has not been possible to evaluate them in terms of either quality or potential confounds. However, studies from three separate research groups in Britain, Holland

and American have failed to find that presence of a companion animal either reduces general cardiovascular levels (a main effect) or moderates reactivity.

In her doctoral thesis, Rajack (1997) examined the reactivity of 58 adult females to three different stressors. Like Allen *et al.*'s study, Rajack examined pet owners with their own pets in their own homes. Half of the participants were dog owners tested with their dog present and the other group were non-owners tested with no animals present. Rajack found no differences between the groups in their reactivity to exercise, reading aloud or startle by an alarm clock. However, the study confounds the presence of a dog with possible differences between dog owners and non-owners, so it is uncertain whether this may have mitigated against finding an effect.

In Holland, Straatman, Hanson, Endenberg and Mol (1997) examined cardiovascular reactivity of male college students to a public speaking task. The dog present condition involved the participants with an unfamiliar dog sitting on their lap whilst they prepared and gave a speech. There was no effect of dog presence on either cardiovascular levels throughout the experiment or reactivity to the task, as assessed by a MANOVA. This experiment differs from the others considered in this section, as the participant was in actual contact with the dog. Although fear of dogs was used to screen participants, a lack of fear may not imply a liking for a strange dog on ones lap, and this may have outweighed or removed any stress moderation.

A pair of American studies on children have also failed to find any convincing effects of a dog's presence on cardiovascular variables. The first study, Nagengast, Baun, Megel and Leibowitz (1997), used a mock medical examination based in a laboratory, with 23 children taking part in two examinations, one with a dog present and one without. Nagengast *et al.* analysed their results with within-subjects factors of dog (absent, present) and time (baseline and five measurements taken during the examination). Nagengast *et al.*'s results are not presented in full, therefore it is difficult to interpret their findings. Nagengast *et al.* do not explicitly state that levels during the

dog present trial were significantly lower than those during the dog absent trial. The main thrust of the Nagengast results are discussion of visual trends in cardiovascular levels over the examination period. It is reported that the presence of the dog produced significantly greater reductions in the cardiovascular variables over the course of the examination than seen in the absence of a dog. However, Nagengast *et al.* did not seem to take into account differences in baseline values for the two trials. For example, the mean arterial pressure for the dog present condition is 5 mmHg higher at the start of the examination than in the dog absent group, therefore this gives more scope for decrease. Given the poor reporting and dubious interpretation of the statistics, Nagengast *et al.*'s claims that a dog present produced a significantly greater reduction in cardiovascular variables over the examination period, compared to a no dog condition, are not convincing.

As an extension to the Nagengast study, Hansen, Baum, Messinger and Megel (in press) examined responses of children undergoing real examinations in a hospital setting. Although they found a decrease in behavioural indices of distress in the dog present group, they report no significant differences in physiological variables according to dog presence. Hansen *et al.* found that the children were not keen to wear the physiological measurement equipment and their movement reduced the number of available measurements (Baun, personal communication). Therefore no useable physiological data was obtained. Given the limitations of both physiological measurements and standardisation in a medical setting, the Hansen study cannot really be said to have fully explored the possibilities of cardiovascular stress reduction in children undergoing medical procedures and therefore there may be more scope for investigation. However it should be noted that the mechanism being proposed for any effects which might be seen in this setting was distraction and this is not a property unique to companion animals and also not necessarily a useful feature in stress moderation in pet owners in the real world.

5.2.1 Conclusions

A summary of the designs and results is given in Table 5.1.

Table 5.1 Design features of studies examining the effect of companion animal presence on cardiovascular variables during an acute stressor.

Study	Participants	Animal	Exposure to dog	Setting	Stressor(s)	Results dog present v. dog absent
Friedmann <i>et al.</i> (1983)	N=36 m&f 9-16 years m=12.2 years	unfamiliar dog	within-subjects	home	reading aloud	<u>main effect</u> SBP dog < alone DBP dog < alone HR ns
Locker (1985)	N=129 m&f 17-35 years m=19.5 years	unfamiliar dog	within-subjects	lab.	reading aloud	<u>main effect</u> SBP ns DBP ns HR dog < alone
Grossberg <i>et al.</i> (1988)	N=32 m age not given	own pet dog	between-subjects	lab.	mental arithmetic thematic apperception test	main effects not analysed, no reactivity effects
Allen (1991)	N=45 f 27-55 years m=39 years	own pet dog	between-subjects	home	verbal mental arithmetic	<u>reactivity effect</u> GSR dog < alone SBP dog < alone DBP & HR ns.
Nagengast <i>et al.</i> (1997)	N=23 m&f 3-6 years	unfamiliar dog	within-subjects	lab.	mock physical examination	? differences in time trends
Rajack (1997)	N=58 f 25-68 years m=43 years	own pet dog	between-subjects	home	exercise reading aloud startle	no main or reactivity effects
Straatman <i>et al.</i> (1997)	N=36 m m=23 years	unfamiliar dog	between-subjects	lab.	public speaking	no main or reactivity effects
Hansen <i>et al.</i> (in press)	N=34 m&f 2-6 years m=3.8 years	unfamiliar dog	between-subjects	health clinic	physical examination	no main or reactivity effects

To summarise, studies of Friedmann *et al.* (1983b) and Locker (1985) found that presence of an unfamiliar dog reduced levels of cardiovascular activity throughout the time it was present and the study of Allen *et al.* (1991) found that presence of the participant's own dog moderated reactivity. However, against these results needs to be set the number of studies that find no effects of any type from presence of a dog.

5.3 Methodological concerns in reactivity experiments

If a study does not find a significant effect, there are two main things to consider. First, given the size of the expected effect, was the sample size of the study sufficiently large to give a reasonable chance of detecting the effect. Second, are there additional sources of variance which might dilute the effect. With reference to companion animal reactivity studies, these two issues are examined in the following sections.

5.3.1 Power

The power of a study reflects its ability to detect as significant an effect if one really exists (Cohen, 1977). This is dependent on the size of effect, the size of the sample, design of the study, the test used and alpha level (Clark-Carter, 1997). Given that the design, alpha level and statistical analysis are usually less flexible, the sample size is seen as the critical determinant of the ability of a study to detect a given size effect. The size of effect can be estimated from a) use of convention to estimate likely size of effect, b) assessment of required effect size for data to be meaningful, or c) estimate from previous studies (Howell, 1992). These three routes were explored to enable an estimation of the likely effect size of stress moderation from a companion animal and therefore examination of whether previous studies have had sufficient power to be realistically likely to detect the effect.

Conventionally, in comparisons of two independent means, a large effect ($d=.80$) accounts for 14% of variance in scores, a medium effect ($d=.50$) accounts for 6% of variance and a small effect ($d=.20$) for only 1% of the variance (Cohen, 1977). Clark-Carter (1997) suggests that large effects are more likely to be expected in physiological research. Thus, as physiological measures are being employed, one might hope for a large size effect in the difference between companion animal present and absent groups.

Given the established nature of cardiovascular reactivity research, it might be expected that standards and norms would exist for what is considered a pathological level of reactivity and by extension what a meaningful moderation of reactivity might be. However, there is no general guide as to a pathological magnitude of cardiovascular reactivity or population norms. Therefore it is not possible to use a theoretical guide as to what is a meaningful size of effect in the research area.

Estimating effect sizes from previous research is also problematic, as many studies do not report sufficient detail to allow effect sizes to be computed. An attempt was made to compute effect sizes from previous companion animal studies, as shown in Table 5.2.

Two studies found significant main effects of dog presence (Friedmann et al, 1983b) and Locker (1985). The effect sizes for both of these studies on heart rate are extremely small, with medium sized effects found by Friedmann *et al.* (1983b) on blood pressure and non-significant effects reported for blood pressure by Locker. Only one study found a significant difference in reactivity between an alone condition and a dog present condition (Allen *et al.*, 1991). As this effect size is from a multivariate analysis, and as no indication of standard deviation of the reactivity is given, it is impossible to reliably estimate effect sizes for individual cardiovascular variables. However, it might be assumed that effect sizes in this study exceed the large size. With the other studies, as the variation between conditions is not statistically

significant with an alpha $p=.05$, it is uncertain whether their non-significant results merely indicate random variation between the means of two groups.

Table 5.2 Power and effect size analyses for companion animal studies

Authors	Design	Condition n	Power at d=.8	Main effect size	Reactivity effect size
Friedmann <i>et al.</i> (1983b)	ws	38	>.99	SBP, d = 0.50 DBP, d = 0.66 HR, d = 0.16	SBP, d = 0.06 DBP = 0 HR = 0
Locker (1985)	ws	129	>.99	SBP=c DBP =c HR, d = 0.16	SBP = c DBP = c HR = c
Grossberg <i>et al.</i> (1988)	bs	16	.59	can't compute due to analysis type ³	
Allen <i>et al.</i> (1991)	bs	15	.64 ^b	$r^2=.91^d$	$r^2=.97$
Nagengast <i>et al.</i> (1997)	ws	23	.95	not reported	not reported
Rajack (1997)	bs	28.0 ^a	.85	n.s	n.s.
Straatman <i>et al.</i> (1997)	bs	18	.64	n.s	n.s
Hansen <i>et al.</i> (in press)	bs	16.8 ^a	.61	SBP = c DBP = c HR = c	SBP = c DBP = c HR = c

Note. Power calculated assuming $\alpha=.05$ and d=.8 for b-s designs or d=1.12 for w-s designs (equivalent to $d=d\sqrt{2}$, to adjust for reduced sampling error in w-s designs).

a= where $n_1 \neq n_2$, harmonic means of n's were calculated

b= based on detecting a difference within a 3-way between-subjects ANOVA

c= effect size calculation not possible due to lack of detail in report but reported non-significant.

d= multivariate effect size

The majority of studies, excluding Allen *et al.* (1991) have very low effect sizes. The effect sizes of Allen are large in comparison and would more than exceed a large effect

3 Grossberg *et al.*'s analysis was based a mixed within x between design. The within subject factors were the 9 measures taken i.e. baseline, reactivity to 4 tasks and recovery to 4 tasks, therefore a within subjects effect reflects the gross difference between these values, highly significant for all measures. The between subjects effect represents a combined effect of the dog on both baseline, reactivity and recovery, non-significant for all variables.

using the conventions of Cohen (1977;1992).

As it was so difficult to estimate effect sizes for companion animal studies, studies which have investigated the effect of non-evaluative passive human companions (the most analogous to a dog presence), on human cardiovascular reactivity, were also consulted. Effect size calculations are shown in Table 5.3.

Table 5.3 Power and effect size analyses for non-evaluative, passive, human companion studies.⁴

Authors	n or n'	Power at d=.8	task	Reactivity results alone v human friend companion	Reactivity Effect size (d)
Kamarck <i>et al.</i> (1990)	19.5	.68	math task	SBP $F(1,35)$ 9.51 DBP ^a HR $F(1,36)$ = 9.13	SBP 0.99 - HR 0.97
			concept formation task	SBP & DBP ^a HR $F(1,36)$ = 6.38	- HR 0.81
Edens <i>et al.</i> (1992)	12	.46	math task	SBP $F(1,21)$ 6.27 DBP $F(1,21)$ 2.60 HR $F(1,21)$ 0.40	SBP 1.02 DBP 0.66 -
Snydersmith & Cacioppo (1992)	11.5	.44	math tasks	HR ^a	
Kamarck <i>et al.</i> (1995)	46	.97 ^b	Stroop test math task	no results given for direct comparison only interaction with factor of threat.	
Kors, Linden & Garvey (1997)	17.0	.70 ^c	math task	Planned comparisons SBP $F(1,46)$ = 6.50 DBP $F(1,46)$ = 5.54 HR not measured	SBP 0.67 DBP 0.69

Note. Participant numbers taken from details in the article. In some cases this does not match the cases in analysis as given by degrees of freedom. If either some cases were discarded prior to the analysis, or other factors were involved to reduce denominator df, this may over estimate the power of the study but under-estimate the effect size.

a= Details not given by authors, as non-significant result.

b= based on detecting an interaction in a 2x2 design.

c= based on detecting a difference within a 3-way-ANOVA

⁴ Note. Formula used for calculation of effect size: $\sqrt{F \left(\frac{n_1 + n_2}{n_1 n_2} \right)}$

Effect sizes for the stress moderation effect of a human companion for systolic blood pressure range from 0.67-1.02, diastolic blood pressure ranging from 0.66-0.69 and HR ranging from 0.26-0.97. These effects would be regarded as medium to large with the exception of the heart rate effects of Edens (1992). Although it should be noted that this summary makes no adjustment for when an individual cardiovascular variable is found non-significant in a study.

The conclusion on attempts to gain an effect size estimate from convention, theoretical rationale and examination of previous studies is that a medium to large effect size might be expected of companion animal presence on reactivity.

The ability of the companion animal studies to detect as significant a large sized effect is given in Table 5.2 (p.115). The .80 power level is taken as a conventional level where one should have a reasonable chance of detecting effects without having to test inordinate numbers of participants (Cohen, 1977). As can be seen, all the within-subject designs have an adequate power to detect large effects and, with their sample sizes, Friedmann *et al.* (1983b) and Locker (1985) also have above .80 power to detect medium effects. Of the between-subjects designs, only that of Rajack (1998) had power above .80 for large effects, the others are in the .60 region. Therefore, it can be concluded that inadequate power is not a overwhelming problem with companion animal studies, although further experiments should ensure that they at least meet criteria of at least .80 power to detect a large effect (see Cohen, 1992 for guidelines).

5.3.2 Extraneous variance

There are a number of sources of variance which may dilute the effect under consideration. These can be split into those due to stable characteristics of the participant, situational factors, measurement characteristics and procedural characteristics. The purpose of this section is to evaluate companion animal studies to see whether they reach acceptable standards in either controlling or recording these sources of variance.

5.3.2.1 Stable characteristics of participant

Shapiro *et al.* (1996) highlight a number of participant characteristics which may affect reactivity or baseline measures of blood pressure. Random allocation should limit the confounding effect of these variables, however, some such as age, sex, body mass, family history of hypertension are particularly important and should be recorded to check that experimental groups do not vary in this regard. Research by Sheffield, Smith, Carroll, Shipley, and Marmot (1997) suggests that smoking status may also affect baseline levels and reactivity to tasks. If these variables are not balanced between experimental groups, then this could introduce additional variance.

Table 5.4 gives details for the companion animal reactivity studies on the screening and selection procedures, allocation to experimental group procedure and the checks made as to whether groups varied on the key variables. As can be seen, companion animal research is fairly consistent in using random allocation to experimental groups which should limit the effect of confounding variables. Key variables of gender and age were held constant or balanced in most studies. However, family history of hypertension was checked in only one study (Straatman *et al.*, 1997) and no studies report checking whether BMI was balanced between experimental groups. In studies using adult participants, non-smokers were selected for two studies (Allen *et al.*, 1991; Straatman *et al.*, 1997) and Rajack (1997) checked for a balance of smokers and non-smokers in her experimental groups but neither Grossberg *et al.* (1988) nor Locker (1985) report checking or screening for smokers.

Fear of dogs was used as screening criterion by all studies which used unfamiliar dogs. However, as Locker noted (1985 p.75), despite all her participants being asked if they minded the presence of a dog prior to taking part in the experiment and answering no, 16.9% of her sample subsequently reported a fear of dogs after the experimental procedure. None of the studies using unfamiliar companion animals checked their participant's attitude towards dogs, which might differ subtly but importantly from fear.

Table 5.4 Screening, selection criteria, pre-experimental controls and check of participant characteristics between dog and alone groups in companion animal studies

Authors	Screening / selection criteria	Group allocation procedure	Checks for individual characteristics balanced between exp. groups.	Situational controls prior to testing
Friedmann <i>et al.</i> (1983)	no fear of dogs	WS design dog exposure. no detail on allocation procedure to order group.	no checks on order group composition reported	none reported
Locker (1985)	no fear of dogs, screened use of hypertensive medication	WS design dog exposure. random allocation to order group.	no checks on order group composition reported	none reported
Grossberg <i>et al.</i> (1988)	all males, no coronary problems, screened medication use	no detail on allocation procedure.	no checks on exp. group composition reported	no smoking or caffeine 2 hours
Allen (1991)	all females, white, non-smokers, dog lovers, screened medication use	random allocation to exp. groups.	exp. groups balanced on: attitudes to pet, length of pet ownership, number of pets, age at first pet.	none reported
Nagengast <i>et al.</i> (1997)	no fear of dogs, no allergies to dogs, no chronic health conditions	WS design dog exposure. random allocation to order group.	order groups balanced on: age, sex, pet ownership status	none reported
Rajack (1997)	all females	no group allocation - groups = dog owners and non-owners	exp. groups balanced on: age, smokers, exercise habits	no smoking 1 hour
Straatman <i>et al.</i> (1997)	all male, in good health, non-smokers, no drug users, no fear of dogs	random allocation to exp. groups.	exp. groups balanced on: age, family history of hypertension, pet ownership, coffee consumption, alcohol consumption, daily stress levels, time of testing	rules to be observed morning and evening before (no extra detail)
Hansen <i>et al.</i> (in press)	no fear of dogs, no allergies to dogs, no immunosuppression, mental development appropriate for age	random allocation to exp. groups	exp. groups balanced on: age, sex, pet ownership status	none reported

Note. WS = within-subjects

5.3.2.2 Acute situational factors

Shapiro *et al.* (1996) also identify a number of situational factors which may affect blood pressure levels. These include: food, fluid, caffeine, sodium, alcohol, smoking, medication use and ambient temperature.

Consideration of companion animal reactivity studies (details in Table 5.4, p.119) shows that only three studies (Grossberg *et al.*, 1988; Rajack, 1997; Straatman *et al.*, 1997) have attempted to control pertinent aspects of participant's behaviour prior to the experimental session. Four of the studies screened for medication use which might affect cardiovascular variables (Allen *et al.*, 1991; Grossberg *et al.*, 1988; Locker, 1985; Straatman *et al.*, 1997). Failure to control for these factors has similar implications as ignoring stable participant characteristics, in that it adds to the variance may be measured and which may dilute the effect of interest.

5.3.2.3 Acclimatisation period

When entering a psychophysiological laboratory, an experimental participant is greeted with a variety of new experiences. Therefore conventionally, a time period is allowed for people to acclimatise to the experimental setting. It is unlikely that a person will be able to relax completely in this type of situation but they should approach a tonic level of arousal that reflects their base levels of stress response to the experimental procedure (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992).

The duration of acclimatisation and baseline periods in companion animal research is given in Table 5.5.

Table 5.5 Duration of acclimatisation period, baseline period and stress task and number of measurements taken for baseline and task level estimates in companion animal studies.

Authors	Acclimatisation period (<i>prior to baseline period</i>)	Baseline period (minutes)	Measurements for baseline estimate	Task length (minutes)	Measurements for task level estimate
Friedmann <i>et al.</i> (1983)	no detail as to length	2	2	2	2
Locker (1985)	1 minute	2	2	2	2
Grossberg <i>et al.</i> (1988)	none reported	6	3	6	3
Allen (1991)	14 minutes BP 14 minutes HR	1	1 BP 3 HR	2	1 BP 3 HR
Nagengast <i>et al.</i> (1997)	none reported	6	3	10	5
Rajack (1997)	5 minutes	1	1 BP 20 HR	2	1 BP peak HR
Straatman <i>et al.</i> (1997)	none reported	10	near continuous	4	near continuous
Hansen <i>et al.</i> (in press)	none reported	variable	variable	2-9	variable

Note. The study of Straatman *et al.* (1997 p.193) which reports a 10 minute baseline period, specifies that cardiovascular measures were averaged over the entire period without specifying if an acclimatisation period was allowed beforehand, therefore it is unclear whether their baseline estimate would include time when the participant was likely to be adjusting to the setting. Friedmann *et al.* (1983 p.462) report a equilibration period prior to measurements but do not specify a time length and the article of Hansen *et al.* (in press) is unclear as to whether an acclimatisation period was allowed.

From this table, it can be seen that the acclimatisation periods range from no time, to a maximum of 14 minutes given by Allen *et al.*, (1991). Although there is no consensus, the majority of expert guidelines recommend periods of at least 10 minutes acclimatisation (Hastrup, 1986; Shapiro *et al.*, 1996), therefore it seems that the length of acclimatisation period in the majority of companion animal studies is too brief.

If a stable baseline is not achieved for each person, comparison of reactivity scores

across groups is less meaningful. For some participants their observable reactivity will be of smaller magnitude than is true. The likelihood of making a type two error, failing to detect a real effect, is also increased if the difference between rest and task levels is smaller than might be expected (Hastrup, 1986). This may explain why previous studies with short (< 10 minutes) acclimatisation periods failed to detect a reactivity effect. Notably, the only study to use a longer acclimatisation period, is the only one to detect a reactivity effect.

5.3.2.4 Reliability of measurements

Once a sufficient amount of time has been allowed for a participants to reach a stable level of activity, the baseline level needs to be assessed. A separate assessment will also need to be made of the task level of activity. Obviously one reading could be taken in each stage. However, as with many assessments where a single measurement can be expected to incorporate a fair amount of noise, a more reliable estimate will be gained if a number of measurements are averaged. There are no accepted guidelines for how many measurements are required to provide a reasonable level of reliability in assessment of cardiovascular activity at various experimental stages (Shapiro *et al.*, 1996). Shapiro *et al.* note that taking three as opposed to two measurements improves reliability by 20% and therefore recommend that three measurements should be the minimum number from which an estimate is determined. These conclusions are reflected in the lower test-retest correlations found for systolic blood pressure reactivity measures based on fewer than three measures of task activity (Swain & Suls, 1996). Although applying generalizability theory (Llabre *et al.*, 1988) suggests that reliability is adequate, above .90, for a within session estimate of blood pressure derived from two or more measurements.

The companion animal research does not often meet criteria of three or more measurements for estimates of baseline and task levels. Table 5.5, (p.121), provides details of the number of measurements from which baseline and task levels were

estimated. Hansen *et al.* (in press) with variable baseline and stressor duration, were unable to standardise the number of measurements in the period and these varied. Only studies of Grossberg *et al.* (1988), Nagengast *et al.* (1997), and Straatman *et al.* (1997) report deriving estimates of both baseline and task levels from three or more measurements.

5.3.2.5 Choice of task

The aim of a psychological reactivity task is to allow an estimation of the psychological contribution to the reactivity. Speech and physical activity have their own unique contributions to reactivity, therefore, reactivity tasks frequently involve little physical movement. However, many tasks use speech. For many years there has been concern as to the degree the cardiovascular reactivity resulting from a verbal task is confounded by the vocal stylistics of the speaker (Brown, Szabo, & Seraganian, 1988). Brown, *et al.* (1988) demonstrated that approximately half the reactivity produced by a verbal mental arithmetic task could be produced by a simple numerical reading task. Additionally, Kamarck (1992) recommends that the use of non-verbal tasks will help increase reliability of cardiovascular reactivity estimates. This suggestion receives support from a meta-review by Swain and Suls (1996) which shows that test-retest reliability of reactivity to verbal tasks is much lower than to non-verbal tasks. This makes a very strong case against using stress tasks with a verbal component.

However, a verbal task often allows a study to manipulate the social nature of the task and may also produce larger magnitude reactivities than a non-verbal task. This may outweigh the previous cautions about using verbal tasks. For instance, Kamarck (1992, p.498) states that when the focus is on detecting experimental effects rather than reliable depiction of individual differences, tasks expected to produce large magnitude reactivities should be used.

Tasks with a verbal element have been frequently used in the research investigating effects of human presence on reactivity. For example, excluding Allen *et al.* (1991), of the 15 studies reviewed in Tables 3.1 and 3.2, 11 have used a task which had a verbal component. These have been serial subtraction (Edens *et al.*, 1992; Kamarck *et al.*, 1990) or other math tasks (Snydersmith & Cacioppo, 1992), presenting a speech (Christenfeld *et al.*, 1997; Glynn, Christenfeld, & Gerin, 1999; Lepore, 1995; Lepore *et al.*, 1993; Uchino & Garvey, 1997), participating in a debate (Gerin *et al.*, 1992; McNeilly *et al.*, 1995) or making judgements (Sheffield & Carroll, 1996). In all these cases, attention has been given to checking that requirements of the task were similar, either by designing tasks to ensure that participants in different conditions speak for the same length of time (McNeilly *et al.*, 1995; Sheffield & Carroll, 1996; Snydersmith & Cacioppo, 1992), or checking that participants spent similar lengths of time talking with similar quality of speech (Gerin *et al.*, 1992; Glynn *et al.*, 1999; Kamarck *et al.*, 1990; Lepore, 1995; Lepore *et al.*, 1993; Uchino & Garvey, 1997). Only Christenfeld *et al.* (1997) and Edens *et al.* (1997) used a performance measure which could have been vulnerable to differences in speaking time.

The companion animal literature has also made heavy use of verbal tasks. Friedmann *et al.* (1983) Locker, (1985) and Rajack (1997) have all used reading aloud tasks, Allen *et al.* (1991) used a verbal mental arithmetic task and Straatman *et al.* (1997) used a public speaking task. However, in none of these studies was any index of rate of speech taken and in all except Allen *et al.* (1991), no account was taken of quality of speech.

5.3.3 Conclusion

There are a number of methodological concerns with the companion animal reactivity studies which may have reduced their ability to detect a significant moderation of reactivity from the presence of a companion animal. These can be spilt into power concerns, where for some studies the sample sizes mitigate against finding significant

anything but the largest effects and concerns that extraneous variance may be introduced to the measurement procedures. Adherence to these standards has been evaluated by the reports available of the studies. However it is accepted that some studies may have used controls not reported in the text of their studies.

From this review it can be concluded that future studies should: a) use sufficient sample sizes to give at least 80% power to detect a large effect as significant; b) use screening procedures or check that experimental groups are balanced for relevant stable characteristics which might affect baseline or reactivity; c) use random allocation procedures to assign participants to experimental groups; d) attend to and control, if possible, participants, pre-experimental behaviour which might affect either baseline or reactivity levels; e) use a sufficient acclimatisation period prior to baseline period; f) ensure that first measurement reading is discarded; g) use a minimum of three measurements to estimate baseline and task levels; and h) if using a stressor with verbal or movement elements, check these are similar or held constant amongst experimental groups.

It is notable that no companion animal studies fulfils all these criteria, therefore despite a number of non-significant results, there would seem scope to repeat experiments whilst using more sophisticated methodology. This conclusion is strengthened by the fact that the study which fulfils the highest number of these criteria, Allen *et al.* (1991), is also the only one to report a significant reactivity effect.

Chapter Six

Experiment One - An attempt to replicate the effect of stress moderation from the presence of a companion animal

6.1 Introduction

The first experiment provided an initial test of whether the presence of a companion animal reduces human cardiovascular reactivity to a laboratory stressor. As shown in Table 6.1, a variety of designs have been used in companion animal research. The following sections review each of these design points to highlight the choices made for this study.

Table 6.1 Summary of design choices of previous companion animal studies

Relationship of animal to participant	Location	Within-subjects exposure to animal	Between-subjects exposure to animal
Own Pet	Participant's home		Allen ^a - adults Rajack - adults
	Standardised		Grossberg - adults
Unfamiliar Animal	Participant's home		
	Standardised	Friedmann - children Locker - adults Nagengast - children	Straatman - adults Hansen - children

Note. a= Allen *et al.*'s (1991) study was a complex design with both between and within subject exposure to the dog and measurements taken in both laboratory and home settings, as described in section 5.2. For the purposes of this table, it has been classified as between-subjects exposure in a home setting, as this is the setting in which significant effects were found.

6.1.1 Choice of setting

Previous companion animal studies have taken place in settings which have been either standardised and identical for all participants such as laboratories, the home of a researcher and health clinics or else home settings where each participant is tested in their own home and thus there are as many experimental settings as there are participants. The aim of the current research programme was to examine the types of mechanisms which might underlie any companion animal stress moderation. Therefore it was envisaged that, at least for the initial experiments, a relatively controllable environment would be required where different aspects might be varied and monitored. This would not be possible in a person's own home where the experimenter would not be able to control setting, conversation, distractions and interruptions. Therefore the selected setting for the experiment was a room at the university.

6.1.2 Choice of companion

Issues of choice of setting and choice of companion are somewhat inter-dependent. It would not seem possible to take an unfamiliar dog into the home of a participant and still preserve control and standardisation across conditions. To do this would require a highly trained dog and usually the absence of other animals in the participant's home. Possibly for these reasons, no previous study has attempted to bring a standard animal into a participant's home. The alternative problem exists in bringing the participant's own pet into the unfamiliar environment of a laboratory. Grossberg *et al.*'s (1988) study is the only one so far to use the participant's own pet in a laboratory setting. They did not find any stress moderation effects and have suggested that an owner's anxiety over the behaviour of their pet in a laboratory situation might mask any stress moderation effects. As the current study was going to be based in a laboratory setting, it was decided not to use the participant's own pet, as this might make it difficult to detect the effect under consideration. Additionally, it was likely that there would be a limited number of participants living within a feasible travelling distance of the University who would have animals which they would be happy about

bringing to the university. Therefore exhausting or depleting this supply in a first experiment may be unwise. An advantage of using an animal unfamiliar to the participant is that the animal can be familiarised with the experimental setting, trained to behave in a certain manner and its behaviour standardised between participants, a degree of control that it would not be possible to have with the participant's own pet. Therefore, it was decided to start testing with an unfamiliar animal whose behaviour could be standardised amongst all sessions.

The experiment could obviously have chosen to use species other than a dog, however for ease of comparison with previous research and due to the biddability of dogs compared to other species such as cats, a canine companion was used.

6.1.3 Choice of design

A within-subjects design using a single testing session means that someone other than the experimenter has to mind the dog during the condition where it is not required. This option has been used by Friedmann *et al.* (1983), Locker (1985) and Nagengast *et al.* (1997). The alternative is to have participants attend on two separate occasions so they can be tested with and without the dog present. The choice of a between-subjects or within-subjects exposure to the dog was determined by pragmatic reasons, that there was only one experimenter available, it was felt to be too difficult to encourage participants to be tested twice and also it would take twice as long to complete the study. Therefore the dog when used, was present throughout the entire experiment and exposure was between-subjects.

6.1.4 Choice of participants

Children, students and middle aged female non-student adults have been used in previous studies. It seems likely that different processes may be occurring in child as opposed to adult participants and given that the aims of the research are primarily to generalise to adult pet-owning samples, it was decided to use an adult sample.

Although some studies have used a single sex sample, there seems no reason to suspect that different processes might be occurring in males than females, therefore both were recruited.

6.1.5 Methodological refinements

This first study aimed to resolve a number of the methodological problems identified in Section 5.3 which might mitigate against finding an effect. Not all the methodological issues raised in Section 5.3 were addressed by the current study, due to the on-going literature reviews which ran in parallel to the design and data collection stages of this study.

The study used both a verbal and a non-verbal stressor. A verbal task was included for comparison to previous companion animal studies. However, since the activity of speaking is believed to influence cardiovascular variables, a check was made on the number of words spoken to see whether this varied by condition. A non-verbal task was selected to provide a task in which vocal stylistics of the participant would not make a difference to the reactivity. Neither task involved much movement and the cardiovascular measurements were taken from the participants non-dominant arm to further reduce artefacts produced by hand or arm movement.

Key characteristics which Shapiro *et al.* (1996) suggest needed to be checked to ensure equivalent groups are tested across experimental factors, were recorded. Additionally, attitude towards dogs was recorded, as this was considered particularly pertinent to studies exposing people to unfamiliar dogs. Measures of state and trait anxiety were also included as these may relate to stress reactivity. Estimates of baseline and task levels were made from three measurements, thus increasing the reliability from an estimate gained from a single measure. To standardise social interaction between the participant and experimenter, a script was devised to cover standard presentation of information and instructions. In addition to being good practice, this helps to guard

against any stress moderation being due to increased social interaction between the experimenter and the participant, promoted by the animal's presence. Finally a power calculation was made so that given the design of the experiment, an 80% power level to detect a large effect was ensured.

6.1.6 Comparison with other stress moderators

In addition to comparing an alone and a companion animal condition, this experiment introduces the comparison with another potential stress moderator - music. Although possible health benefits are often emphasised in discussions of stress reduction from companion animals, this effect is seldom compared with other stress moderators. Katcher *et al.* (1983) suggest that the effects of a dog may be due to attention to factors outside the environment and that other stimuli such as music or a visual signal may have a similar effect. This may suggest that the animal is merely acting as distraction or pleasant focus and this role could be fulfilled by other objects or features.

Music was chosen to compare with companion animal presence as it has a similar reputation as a stress moderator. Music is frequently used as an aid to relaxation by the general public. A number of studies have shown that music reduces state anxiety type feelings in laboratory (Avants, Margolin, & Salovey, 1990-91; Davis & Thaut, 1989) and in medical situations (Robb, Nichols, Rutan, Bishop, & Parker, 1995). Additionally, one study has reported that music reduces cardiovascular reactivity to stressors. Allen and Blascovich (1994), in a study of surgeons, report that music significantly reduces blood pressure and heart rate reactivity during a mental arithmetic stressor.

6.1.7 Summary of design

The current experiment incorporated three between-subjects conditions: a control condition where only the experimenter was present, and two other conditions

involving the addition of either a dog present, or relaxing music playing. This allows the potential stress moderating effects of the presence of a companion animal to be compared against a control condition with no dog and another experimental condition of music playing. The dog used for the experiment was unfamiliar to the participants. Participants were adults and all were tested at University premises. The eventual formula was a compromise between pragmatic considerations in that this was the first experiment in a series and thus certain 'rarer' participants ought not be used on a preliminary study and considerations due to the industrial nature of the studentship. The experiment was the second in a set of two studies for a separate project, therefore some aspects were already set to match the earlier study.

6.2 Method

6.2.1 Power calculations

The number of participants for the experiment was determined by power considerations. The experiment met requirements of an 80% likelihood to detect a large size main effect in a 2x2x3x2 ANOVA (Between-subjects factors of Sex, Age, Experimental Group and Task).

6.2.2 Participants

Eighty adults participated in the experiment. The majority were working in non-academic university positions and recruited from a university subject pool or by poster campaign. There were 35 men and 45 women, ranging in age from 25 to over 55 years. None of the participants knew the experimenter before the study. Participants did not report any history of heart or circulatory conditions or any health condition which might put them at risk from repeated blood pressure measurement (guidelines from Fisher, 1996), nor were they taking any medication which might affect the cardiovascular system. Participants were paid £2.50 to compensate them for their

time.

Participants were allocated between the three conditions according to the availability of the dog, and then between control and music conditions randomly. Each participant completed two stress tasks to enable the effects of a verbal and non-verbal task to be compared. The order of tasks was counter-balanced to allow distinction between task and order effects. Allocation to task order condition was random. The number of participants in each experimental cell are shown in Table 6.2:

Table 6.2 Male and female participant distribution within experiment one design cells

Task Order	CONTROL	MUSIC	DOG	TOTAL
ORDER 1 (math-read)	13 (5/8)	13 (6/7)	13 (6/7)	39 (17/22)
ORDER 2 (read-math)	14 (7/7)	12 (5/7)	15 (6/9)	41 (18/23)
TOTAL	27 (12/15)	25 (11/14)	28 (12/16)	80 (35/45)

Note. Total numbers per cell shown, with male / female breakdown in brackets.

6.2.3 Tasks

The two stress tasks were chosen to enable the effects of both a verbal and non-verbal challenge to be examined.

6.2.3.1 Reading task

Reading tasks are commonly used in cardiovascular reactivity research and consistently trigger increases in SBP, DBP and HR of 5-10 mmHg / bpm (Linden, 1987). The reading in this experiment consisted of text from a non emotive text about Pacific Islanders (Gladwin, 1970 p.130-134). The readability of this piece of text was estimated using the Flesch formula (Flesch, 1962):

$$\text{Reading Ease} = 206.835 - 0.846(\text{syllables per 100 words}) - 1.015(\text{average sentence length})$$

An average of the score for the first 100 words or at least three sentences of each page was computed. A higher reading score indicates an easier piece of text to read. The readability for the text used in this experiment was 50. This is classed as a fairly difficult piece of text using guidelines of Ley and Florio (1996). To compare these to the reading texts used in previous companion animal experiments, a score for the two samples of text used by Locker (1985) was computed based on three samples of 100 words. Locker's two texts had reading ease scores of 53 and 42 respectively, which are classed as fairly difficult and difficult respectively (Ley & Florio, 1996). The '*tabloid line*' which is at the level of most UK tabloid newspapers is a reading ease of 70 or higher (Ley & Florio, 1996), thus reading the texts in these experiments can be considered a stressor to most people.

The reading task consisted of five pages of text, each containing approximately 270 words, consecutively presented on computer screen for one minute. Page length was piloted so that no participant would be able to complete reading the page in the available time. Participants were requested to read aloud and to read as much as possible on each page, whilst striving to remain accurate. When the next page was presented, the participants were told to continue reading at the top of the fresh page. The total number of words read by the participant was noted.

6.2.3.2 Mental Arithmetic Task

Previous research using a mental arithmetic task has found that it produces significant rises in cardiovascular variables over baseline (Kamarck, 1992). The most common task is serial subtraction - this requires the subject to subtract aloud by set increments from a large starting number. However, it was felt that this might not be suitable for a written exercise as patterns in the numbers would be apparent. Therefore, the math tasks was designed so that participants could non-verbally report their answers to problems in which a visual pattern would not be apparent.

The math tasks consisted of twenty addition problems using six numbers ranging from -10 to 10, see Appendix A. The answers produced were a mixture of positive and negative numbers. The problems were presented consecutively, each being displayed for 15 seconds on a computer screen. Participants were required to write their answers on an answer sheet. No feedback was given to participants during the course of the task. The number of correct answers was noted.

6.2.4 Apparatus

A Macintosh IIfx Computer was used to present the stress tasks and to ensure that timing within the experiment was kept constant.

A Critikon Dinamap Vital Signs Monitor model 8100 was used to monitor the cardiovascular variables. A description and specification of the Dinamap is given in Appendix B. The Dinamap cuff was placed over the brachial artery of the participants non-dominant arm. The Dinamap displays the participants' systolic and diastolic blood pressure, mean arterial pressure and heart rate.

6.2.5 Measures

6.2.5.1 State-Trait Anxiety Inventory

To check whether there were group differences in anxiety, a factor which might affect reactivity, participants were given the Trait portion of the State-Trait Anxiety Inventory (Form Y) (Spielberger, 1983). Trait anxiety is hypothesised to be a fairly stable personality construct which reflects individual differences in tendency to perceive situations as stressful and to react with increases in state anxiety (Spielberger, 1983). The state anxiety section of the inventory was also administered to assess the effect of the stress task on subjective feelings of anxiety and to examine whether these differed by condition. This provides a subjective rating of the participant's anxiety levels normally (trait) and with specific reference to the

experimental period (state). Both state and trait portions of the questionnaire were given once at the end of the physiological measurement phase of the experiment. The use of this measure has been validated and norms are available for a similar populations (Spielberger, 1983). Each scale consists of 20 statements to which participants have to indicate their agreement on a 1-4 scale.

6.2.5.2 General Health Profile

Salient demographic characteristics which might affect cardiovascular reactivity were recorded to check that groups were balanced in these regards (Shapiro *et al.*, 1996). Age was recorded on a four category scale, 25-34 years, 35-44 years, 45-54 years, 55+ years. Health was rated on a four point scale; Excellent, Good, Fair, Poor. Participants were asked if they undertook regular exercise, whether they smoked, and the average number of alcohol units they consumed per week. They were also asked two questions pertaining to their attitudes to pets: 1) whether there were any pets in their household and 2) their attitudes towards dogs. The latter was measured on a seven point scale anchored at '*dislike dogs intensely*' and '*like dogs intensely*'.

The questionnaire also assessed pre-experimental behaviour which might affect baseline or reactivity measures. At the end of the measurement phase, participants completed a checklist detailing their eating, drinking, exercise and smoking habits generally and immediately prior to the experiment. Participants had not been asked to restrict their behaviour prior to the session in any way: an oversight which became apparent during further literature reviews conducted in parallel to the design of the study. A copy of the questionnaire can be seen in Appendix C.

6.2.5.3 Cardiovascular variables

Cardiovascular variables of systolic blood pressure, diastolic blood pressure, heart rate and mean arterial pressure were measured at two minute intervals throughout the measurement phase. Each assessment takes 20-45 seconds to complete; although if the

participant moves during the process, this can disrupt the procedure and the measurements can last up to 2 minutes before the monitor cuts out. During the measurement process, the pressure in the cuff occludes the veins and thus blood is prevented from leaving the arm. This can lead to venous pooling which is both uncomfortable for the participant and may lead to artefactually inflated diastolic measurements.

The Dinamap (8100) allows a choice between 1, 2 and 3 minute intervals for recording. In pilot testing, the 1 minute setting was rated as too uncomfortable for many participants. Goodman, Dembroski and Herbst (1996) state that use of a measurement interval of less than 90 seconds leads to blood pooling. In this experiment, the two minute interval was used as an acceptable compromise between comfort and maximising measurements. In addition, an individual measurement attempt was abandoned if assessment took over 1 minute. This ensured a minimum of 1 minute ordinary blood flow between measurements.

6.2.6 Procedure

Participants were greeted with minimal social interaction occurring, any conversational openings made by the participant were politely responded to and curtailed with the participant being led quickly to their chair and the experimental procedure started.

In the dog group, a dog was positioned on a bean bag about 15 feet away from the participant. Although the dog was free to move within a limited area, the amount of movement made by the dog during the majority of experimental sessions was minimal. The participant could easily see the dog by shifting their gaze from the computer screen. The same dog was used throughout the study, he was a male Brittany, 5 years old, approximately 50 cm high at the shoulder and 19 kg weight. This breed of dog is fairly unusual and would not be likely to have been encountered and thus participants would be unlikely to have any prior prejudices about the breed. A picture of the dog

can be seen in Appendix D. He was selected for his good temperament, docility and ease of availability. He was owned by another postgraduate student and housed off-campus, but was familiar with the university premises. The procedure was approved by the owner of the dog as being ethically sound.

For the music group, a selection of Baroque music was played during the experimental session (Rondo Classics, 1995). The music was played at low volume and was selected for its harmonic and tempo characteristics that would be expected to induce relaxation (Robb *et al.*, 1995).

In both of the treatment groups, the music or dog was present in the room as the participant entered and remained for the duration of the session. If reference was made to either the music or the dog's presence, it was stated that it was part of the experiment. Participants were not allowed to greet or interact with the dog.

A diagram of the procedure is given in Figure 6.1. Participants were seated comfortably in front of the computer. They were read a standard set of instructions informing them of the nature of the study and consent was gained. In particular participants were asked not to talk or ask questions when wearing the blood pressure cuff and not to make large movements. An appropriate monitoring cuff was then fitted on the participant's non dominant arm.

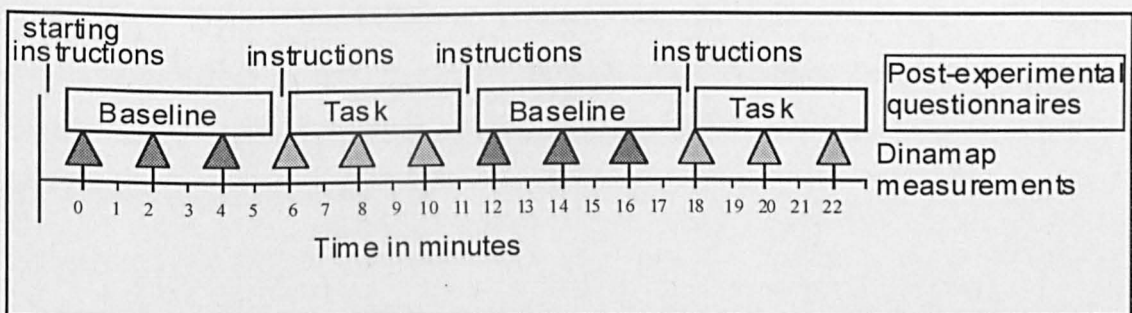


Figure 6.1 Plan of the procedure for experiment one.

Cardiovascular measurements were taken at two minute intervals throughout the experiment. The first measurement period was a six minute baseline period where the participant was asked to rest quietly, measurements were taken at 0:30, 2:30 and 4:30 minutes into the baseline period. Instructions were then given for the first task. The tasks lasted for 5 minutes with measurements taken at 0, 2 and 4 minutes into the task period. A second six minute baseline period then occurred, followed by the final task, again lasting 5 minutes, measurement timing as before.

After both tasks had been completed, the pressure cuff was removed and participants were asked to complete the demographic and pre-experimental behaviour questionnaires. At the end of the experiment, the participants were debriefed, paid and allowed to ask any questions or make comments regarding the procedure. Total testing time for each participant was about 40 minutes.

6.3 Results

Results are presented in the following order. First comparison of participant characteristics in each condition. Second, analysis of physiological data. Third, analysis of subjective anxiety, including differences across conditions, and its relationship to physiological data. Fourth, task achievement across groups and its relationship to physiological data.

6.3.1 Participant characteristics

Analyses of variance, Kruskal-Wallis tests and Chi-square tests were used as appropriate to examine whether participants differed in important aspects across experimental groups. Details are given in Table 6.3. All quantitative variables for which parametric tests were run met assumptions of normality and homogeneity of variance. An alpha level of .05 was used for all statistical tests.

There were no significant differences between the groups on their age, subjective health rating, trait anxiety score, attitude towards dogs, resting blood pressures, resting heart rate. Trait anxiety levels were slightly higher than the norms given for American working adults of 34.9 for males and 34.8 for females (Spielberger, 1983). In this sample, the mean score for males was 37.9 whereas for females it was 37.7. Distributions of males and females, pet owners, regular smokers and regular exercisers were similar across groups. It can be concluded that the three experimental groups were balanced with regard to the major individual variables which might be expected to affect baseline and reactivity.

Table 6.3 Group variations in salient demographic and attitudinal variables.

Variable	Control n=27	Music n=25	Dog n=28	Analysis
dichotomy ratio				
Sex. (male: female)	12:15	11:14	12:16	$\chi^2(2, N=80) = 0.02$, $\phi=.01, p=.99$
Pet ownership status (owner/ non owner)	15:12	13:12	13:15	$\chi^2(2, N=80) = 0.47$, $\phi=.08, p=.79$
Regular exerciser (yes:no)	20:7	17:8	15:13	$\chi^2(2, N=80) = 2.68$, $\phi=.18, p=.26$
Regular smoker (yes:no)	6:21	1:24	6:22	$\chi^2(2, N=80) = 4.02$, $\phi=.22, p=.13$
median (interquartile range)				
Age category (1=25-34, 2=35-44, 3=45-54, 4=55+)	3 (2)	4 (1)	3 (2)	$H(2, N=80) = 2.22$, $R^2=.03, p=.33$
Subjective health rating (1= excellent, 4= poor)	2 (1)	2 (1)	2 (1)	$H(2, N=80) = 1.03$, $R^2=.01, p=.60$
mean (standard deviation)				
Trait anxiety ^a	36.4 (8.8)	39.4 (10.0)	37.6 (8.2)	$F(2,73) = 0.70$, $R^2=.02, p=.50$
Attitude towards dogs ^b (1= dislike dogs intensely, 7= like dogs intensely)	4.7 (1.5)	4.8 (1.4)	5.2 (1.2)	$F(2,75) = 0.80$, $R^2=.02, p=.46$
Alcohol (units per week)	11.1 (13.2)	6.6 (8.2)	11.2 (11.7)	$F(2,77) = 1.41$, $R^2=.04, p=.25$
Baseline systolic blood pressure (mmHg)	128.1 (16.9)	129.1 (13.9)	125.0 (13.3)	$F(2,77) = 0.58$, $R^2=.02, p=.56$
Baseline diastolic blood pressure (mmHg)	74.2 (13.1)	74.1 (11.4)	73.0 (11.3)	$F(2,77) = 0.10$, $R^2<.01, p=.91$
Baseline heart rate (bpm)	74.4 (14.1)	69.8 (11.1)	68.0 (9.0)	$F(2,77) = 1.15$, $R^2=.05, p=.32$

Note. a= For 4 participants, missing data on one trait anxiety scale item was replaced by the mean for the rest of the scale, as per instructions of Spielberger *et al.* (1983). Where missing data was caused by omission of more than one item, these participants scores were not computed, this resulted in 4 cases with missing data in the ratio 1:0:3 for control, music and dog groups respectively.

b = missing data on dog attitude scale for 2 participants.

Numbers of participants engaging in behaviour likely to affect cardiovascular levels was monitored. Only 4% reported smoking and 1% reported alcohol use in the two hours prior to the experiment. These frequencies were low and evenly spread between groups, see Table 6.4.

Table 6.4 Adherence to pre-experimental controls

Restriction time frame	Able to adhere (yes: no)			Analysis
	Control <i>n</i> =27	Music <i>n</i> =25	Dog <i>n</i> =28	
Alcohol < 2 hours	27:0	24:1	28:0	$\chi^2(2, N=80) = 2.23, \phi=.17, p=.33$
Smoking < 2 hours	26:1	25:0	26:2	$\chi^2(2, N=80) = 1.87, \phi=.15, p=.39$
Eating & drinking < 2 hours	4:23	10:15	6:22	$\chi^2(2, N=80) = 4.68, \phi=.24, p=.10$
Caffeine < 2 hours	18:9	18:7	16:12	$\chi^2(2, N=80) = 1.33, \phi=.13, p=.51$

More participants, 75%, reported food or fluid intake in the two hours prior to the experiment. This was probably as the sample of university based workers were frequently tested in their lunch hour. To explore this further, exactly what people reported eating and drinking was classified as: 'snack' for anything less than a sandwich, including sweets and fruit only; 'meal' for a sandwich to substantial meal; or 'no food' for people reporting nothing, or those only reporting drinks. Within this classification it was also noted whether people reported consumption of anything likely to contain caffeine such as colas, coffee or tea. Independent classification by a second rater produced 100% agreement. A Chi-square analysis evaluated whether numbers of people reporting caffeine was unevenly distributed between conditions, this was non-significant, see Table 6.4. Food consumption did not differ significantly by experimental group, $\chi^2(4, N=80) = 6.64, \phi=.29, p=.16$, see Table 6.5.

Table 6.5 Pre-experimental food consumption in each experimental group.

Food Consumption	Control <i>n</i> =27	Music <i>n</i> =25	Dog <i>n</i> =28
No food	13	11	9
Snack	9	13	11
Meal	5	1	8

Note. Numbers of people consuming 'no food' do not match numbers 'not eating or drinking' in Table 6.4, as some participants just reported liquid intake.

6.3.2 Physiological data

6.3.2.1 Analysis strategy

For each participant, an average of the three measurements in each stage of the experiment was taken, thus producing four values per participant Baseline1, Task1, Baseline2, Task2. The four values were examined in terms of whether they were a task level for the reading or math task and whether they were a baseline preceding the math or reading task.

A MANOVA was used to analyse this data. An alternative strategy might have been to use repeated univariate ANOVAs or possibly ANCOVAs with baseline levels as a co-variate. The rationale given for using the baseline ANCOVA strategy is that it removes any 'law of initial values' effects (e.g. Kamarck *et al.*, 1990). The law of initial values suggests that the magnitude of a response is inversely proportional to the closeness of the starting level to basal activity (Wilder, 1967). For cardiovascular activity, this presumes a static task level which a person always reaches regardless of initial activation. This however is a 'within' subject effect whereas the ANOVA strategy estimates a baseline control across all participants i.e. between-subjects, and it is not clear how close this is to individual basal levels of activity. Additionally, this would seem a particularly flawed strategy to use with a two sex sample and an age range who may have a broad range of baseline activity levels. Multiple ANOVAs inflate the likelihood of making a type one error. Using a MANOVA and proceeding with univariate ANOVAs only if the MANOVA is significant, gives a useful degree of

protection against an inflated type one error rate. MANOVA is not a perfect solution to this problem (Huberty & Morris, 1989) but it has the added advantage of being sensitive to differences between conditions in terms of combinations of the dependent variables, as well as or instead of univariate differences. Thus, if a significant MANOVA is followed up by univariate ANOVAs, none of which is significant, tests can then be carried out on linear combinations of the dependent variables (canonical variables). Huberty suggests that it is not appropriate to follow-up a MANOVA with univariate tests; however univariate differences are often much simpler to interpret than multivariate tests, and on these grounds it seemed sensible to examine them first.

Mean arterial pressure was not analysed formally during this study, as it is very highly correlated with diastolic and systolic blood pressure, $>.85$. Inclusion of this variable would have led to multicollinearity problems.

The main analysis was a six way multivariate analysis of variance (MANOVA) with three dependent variables of systolic BP, diastolic BP and heart rate. The between-subjects factors were GROUP with three levels (control; music; dog); ORDER with two levels which indicates in which order the tasks were presented for each participant (order1, math then read; order2, read then math); AGE (young, 25-44 years; old 45+ years); SEX (male, female); and within-subject factors were TASK-TYPE with two levels (math; read) and PHASE with two levels (baseline level; task level). Biological sex was included as a factor as this has been found to have a significant effect on resting cardiovascular activity and reactivity (Matthews & Stoney, 1988). The sample covered a wide age range of over 30 years, therefore it seemed prudent to include age as a factor in analyses. Due to limited numbers of observations in some cells, a restricted model was used for the between-subjects effects, examining only main effects, two-way interactions and the three-way interaction of ORDERxAGExGROUP. No other three-way between-subjects interactions or the four way between-subjects interaction were tested. This led to a d.f. denominator of 63, which is compatible with the power requirements of 80% to

detect a large effect for a 3 level factor in a mixed factorial design such as this.

A full summary table for the MANOVA is shown in Appendix E, the analyses of interest are described below. It was expected from epidemiological trends, that males would have higher blood pressure levels but lower heart rates than females and that older participants would have higher blood pressure levels and lower heart rate than younger participants. The main effect of GROUP was examined to determine whether there were any differences in both baseline and task levels between the control, music and dog groups. No explicit hypothesis was made for group differences, although prior research suggests that the cardiovascular levels of the dog group might be lower than for the control condition. The main effect of PHASE would show the significance of any differences between the participants baseline and task levels i.e. their reactivity. It was expected that both tasks would produce increases in cardiovascular activity. Reactivity was also examined with regard to factors of SEX, AGE and ORDER of task presentation. It was expected that males would have larger blood pressure reactions than females, but that heart rate differences would be minimal. Older participants were expected to react with greater blood pressure reactions but lower heart rate reactions than younger participants. The interaction between PHASE and GROUP, would show whether there were differences in reactivity between the groups. Again, explicit hypotheses were not generated, but on the basis of some previous research, it might be expected that reactivity for the dog and music groups might be lower than the control group.

6.3.2.2 Main effects of age, sex and order

There were main effects of both SEX and AGE as expected. Older participants (age 45-55+ years) differed from younger participants (age 25-44 years) in cardiovascular activity, Wilks's $\Lambda = 0.87$, $F(3,61) = 3.13$, $p = .03$. As expected, older participants had higher blood pressure and lower heart rate levels. Subsequent univariate analyses showed this effect to be significant for systolic blood pressure only. These results can

be seen in Figure 6.2.

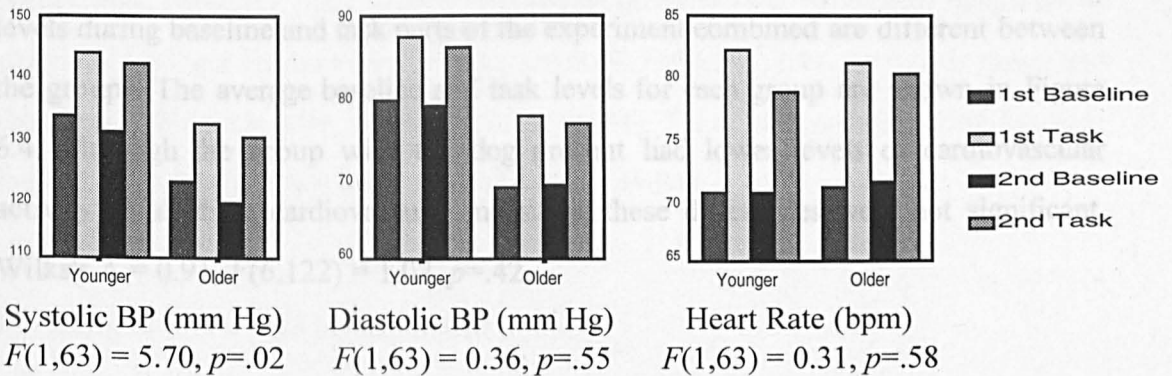


Figure 6.2 The main effect of age on cardiovascular variables.

Cardiovascular activity also varied by gender of participant, Wilks's $\Lambda = 0.75, F(3,61) = 6.95, p<.01$. As expected, blood pressure levels were higher for males than females, but heart rate levels were similar. Subsequent analyses show this effect to be significant for systolic and diastolic blood pressure only, as shown in Figure 6.3.

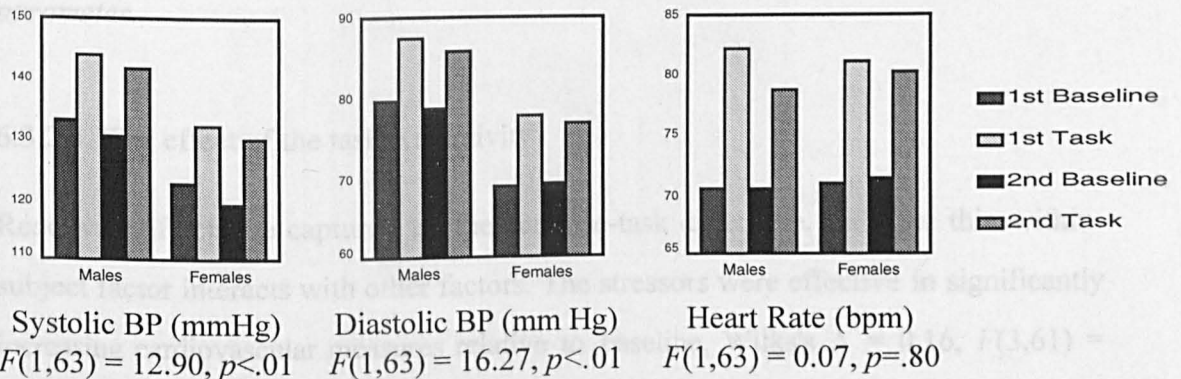


Figure 6.3 The effect of participant's sex on cardiovascular variables.

There was no interaction between factors of AGE x SEX, Wilks's $\Lambda = 0.91, F(3,61) = 2.05, p=.12$. There was no significant difference in the cardiovascular activity levels of the participants randomly allocated to the two different task orders, Wilks's $\Lambda = 0.89, F(3,61) = 2.46, p=.07$.

6.3.2.3 Main effect of experimental group

This analysis investigates whether there are any main effects of GROUP, i.e. whether levels during baseline and task parts of the experiment combined are different between the groups. The average baseline and task levels for each group are shown in Figure 6.4. Although the group with the dog present had lower levels of cardiovascular activity on all three cardiovascular measures, these differences were not significant, Wilks's $\Lambda = 0.91$, $F(6,122) = 1.02$, $p = .42$.

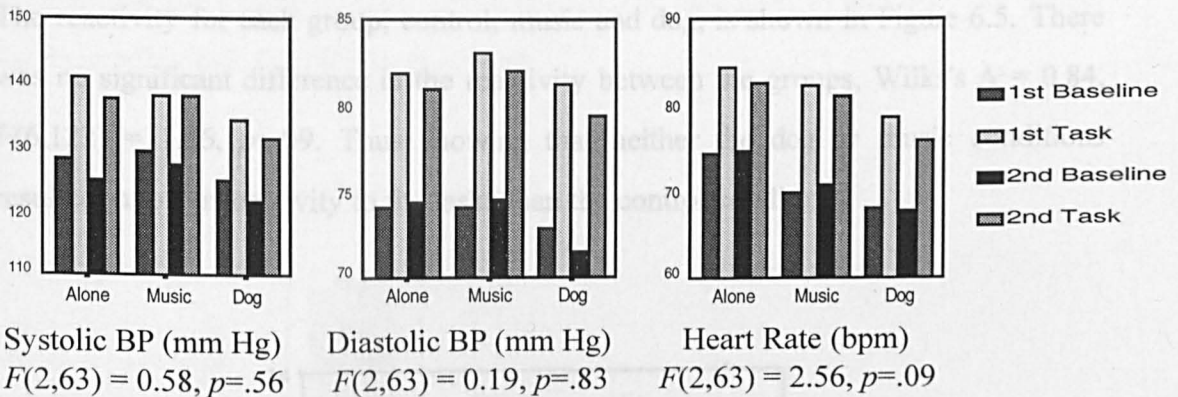


Figure 6.4 Mean baseline and task levels for each group and each physiological parameter.

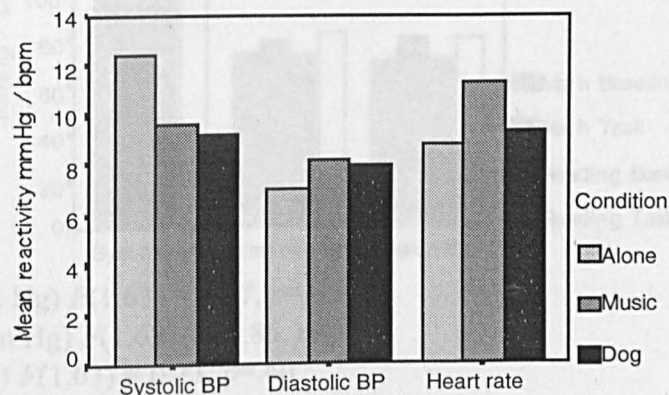
6.3.2.4 The effect of the tasks (reactivity)

Reactivity effects are captured by the baseline-task difference, and how this within-subject factor interacts with other factors. The stressors were effective in significantly increasing cardiovascular measures relative to baseline, Wilks's $\Lambda = 0.16$, $F(3,61) = 103.96$, $p < .01$. Subsequent univariate tests indicate that this effect was significant for all three variables. An additional MANOVA confirmed that this effect held for both tasks. Average reactivity for the math task was 9.5 mmHg ($SD=8.5$) systolic blood pressure, 5.7 mmHg ($SD=5.3$) diastolic blood pressure and 9.5 bpm ($SD=6.7$) heart rate. Average reactivity for the reading task was 11.3 mmHg ($SD=7.6$) systolic blood pressure, 9.7 mmHg ($SD=5.7$) diastolic blood pressure and 9.9 bpm ($SD=6.5$) heart rate.

It had been expected that both older and male participants would have had higher blood pressure reactivity and lower heart rate reactivity than female and younger participants. However, there were no significant differences in the overall reactivity of older and younger participants (Wilks's $\Lambda = 0.89$, $F(3,61) = 2.44$, $p=.07$) or males and females (Wilks's $\Lambda = 0.99$, $F(3,61) = 0.28$, $p=.84$). There was no interaction between these factors, Wilks's $\Lambda = 0.93$, $F(3,61) = 1.44$, $p=.24$).

6.3.2.5 Group differences in reactivity

The reactivity for each group, control, music and dog, is shown in Figure 6.5. There was no significant difference in the reactivity between the groups, Wilks's $\Lambda = 0.84$, $F(6,122) = 1.86$, $p=.09$. Thus showing that neither the dog or music conditions resulted in lower reactivity to the tasks than the control condition.



Systolic BP (mm Hg) $F(2,63) = 1.33$, $p=.27$

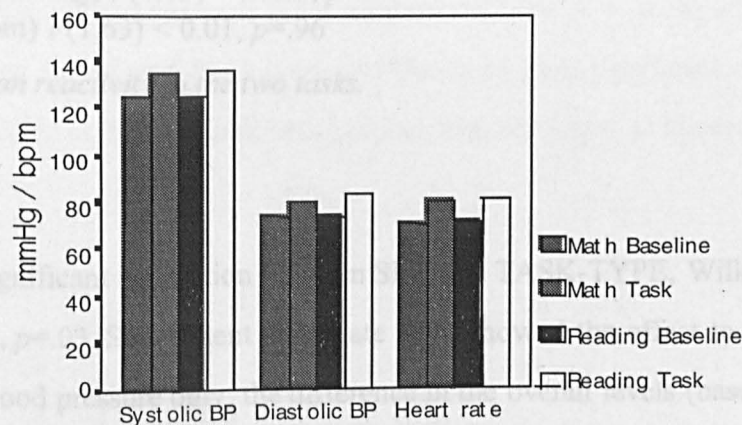
Diastolic BP (mm Hg) $F(2,63) = 0.64$, $p=.53$

Heart Rate (bpm) $F(2,63) = 1.07$, $p=.35$

Figure 6.5 Mean reactivity (task level minus baseline) for each cardiovascular variable by group.

6.3.2.6 Differences between the tasks

The main effect of TASK-TYPE was significant Wilks's $\Lambda = 0.80$, $F(3,61) = 5.25$, $p < .01$. Thus indicating that overall cardiovascular activity (composed of baseline and task levels) for the reading task were greater than for the maths task. Figure 6.6 shows the baselines preceding each task and task levels of activity. This effect was significant at the univariate level only for diastolic blood pressure. Separate MANOVAs on baseline or task data confirmed that this effect was produced by a difference in task levels and not a difference in preceding baselines. Therefore, although the baselines were similar for whichever task they preceded, the task level of activity was greater for the reading task than for the math task.



Systolic BP (mm Hg) $F(1,63) = 0.87$, $p = .35$

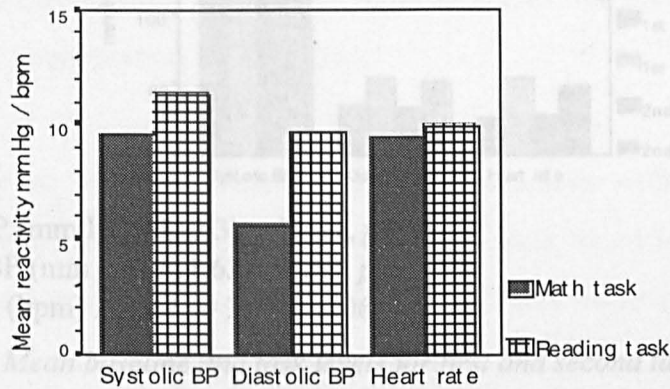
Diastolic BP (mm Hg) $F(1,63) = 15.86$, $p < .01$

Heart Rate (bpm) $F(1,63) = 0.73$, $p = .40$

Figure 6.6 Mean baseline and task levels for math and reading tasks.

This main effect of cardiovascular levels being greater for the reading task than for the math task was reflected by the interaction between PHASE and TASK-TYPE indicating that reactivity was greater for the reading task than the maths task, Wilks's $\Lambda = 0.65$, $F(3,61) = 10.76$, $p < .01$. Subsequent univariate F tests indicate that this effect was significant only for diastolic blood pressure, with the reading task

producing a greater rise in pressure than the maths task. Reactivity for each task can be seen in Figure 6.7.



Systolic BP (mm Hg) $F(1,63) = 2.52, p=.12$

Diastolic BP (mm Hg) $F(1,63) = 31.25, p<.01$

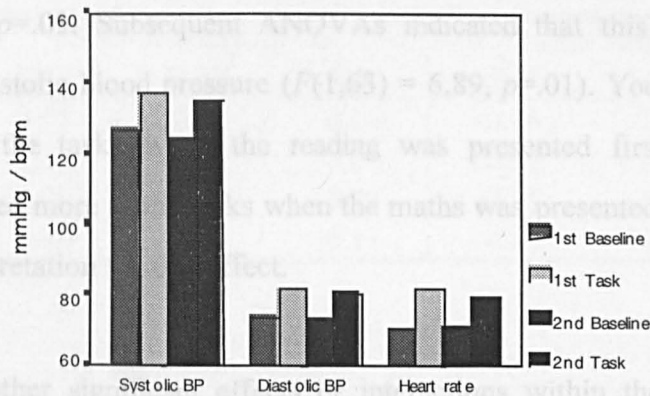
Heart Rate (bpm) $F(1,63) < 0.01, p=.96$

Figure 6.7 Mean reactivity to the two tasks.

There was a significant interaction between SEX and TASK-TYPE, Wilks's $\Lambda = 0.86$, $F(3,61) = 3.30, p=.03$. Subsequent univariate tests showed the effect to be significant for diastolic blood pressure only, the difference in the overall levels (baseline and task level combined) between the two tasks is greater for the males than females.

6.3.2.7 Order effects: differences between first and second task

Due to the nature of the analysis, differences between the first and second half of the experiment are carried by TASK x ORDER interactions. There was a significant interaction for TASK x ORDER, Wilks's $\Lambda = 0.76$, $F(3,61) = 6.27, p<.01$. This effect was significant only for systolic blood pressure and was due to cardiovascular activity being higher for the first half of the experiment than the second half, as shown in Figure 6.8.



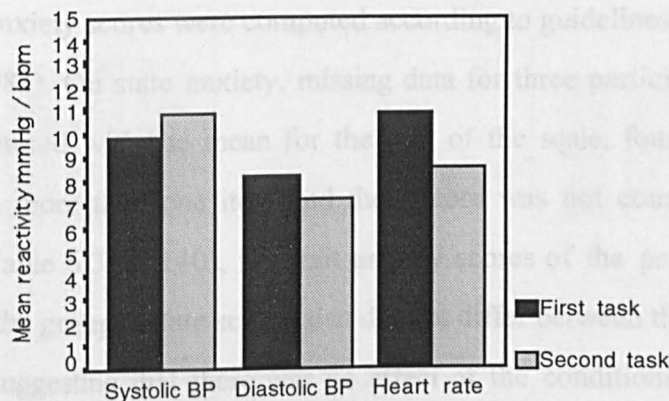
Systolic BP (mm Hg) $F(1,63) = 17.41, p < .01$

Diastolic BP (mm Hg) $F(1,63) = 1.67, p = .20$

Heart Rate (bpm) $F(1,63) = 3.56, p = .06$

Figure 6.8 Mean baseline and task levels for first and second task.

Reactivity to the first and second tasks differed, Wilks's $\Lambda = 0.78, F(3,61) = 5.59, p < .01$, as shown in Figure 6.9. Univariate differences were significant only for heart rate with reactivity to the first task being higher than reactivity to the second task.



Systolic BP (mm Hg) $F(1,63) = 0.67, p = .42$

Diastolic BP (mm Hg) $F(1,63) = 1.06, p = .31$

Heart Rate (bpm) $F(1,63) = 9.55, p < .01$

Figure 6.9 Mean reactivity for first and second task.

There was a significant interaction, PHASE x ORDER x AGE, Wilks's $\Lambda = 0.86$, $F(3,61) = 3.33$, $p=.03$. Subsequent ANOVAs indicated that this effect was only significant for diastolic blood pressure ($F(1,63) = 6.89$, $p=.01$). Younger participants reacted more to the tasks when the reading was presented first, whereas older participants reacted more to the tasks when the maths was presented first. There was no obvious interpretation for this effect.

There were no other significant effects or interactions within the MANOVA. In summary, although expected sex and age trends were found in baseline levels, these were not evidenced in reactivity differences. There were no experimental group differences in either combined baseline and task levels or in reactivity to either task. Reading produced higher diastolic blood pressure reactivity than the math task. Systolic blood pressure levels declined significantly over the course of the experiment. Heart rate reactivity was higher to the first than second task.

6.3.3 Subjective anxiety

State and trait anxiety scores were computed according to guidelines in the test manual (Spielberger, 1983). On state anxiety, missing data for three participants on one test item was substituted with the mean for the rest of the scale, four participants had missing data on more than one item and their score was not computed. As shown previously in Table 6.3, (p.140), the trait anxiety scores of the participants did not differ between the groups. State scores also did not differ between the groups, $F(2,73) = 0.94$, $p=.40$ suggesting that there was no effect of the conditions on state anxiety levels.

State anxiety scores did not relate to cardiovascular reactivity for either task, nor depending on which task was presented first or second. Correlations with trait anxiety were higher, however, when Bonferonni adjustment was used to control for the multiple comparisons, these correlations were non-significant, see Table 6.6.

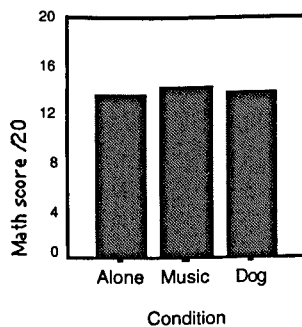
Table 6.6 Correlations between cardiovascular reactivity and anxiety

	State Anxiety, n=76			Trait Anxiety, n=76		
	SBP	DBP	HR	SBP	DBP	HR
Math task	0.08	0.10	0.14	-0.16	0.02	-0.13
Reading task	0.11	0.01	0.03	-0.19	-0.24*	-0.23*
First task	0.09	0.10	0.02	-0.16	-0.00	-0.25*
Second task	0.10	0.07	0.17	-0.20	-0.19	-0.09

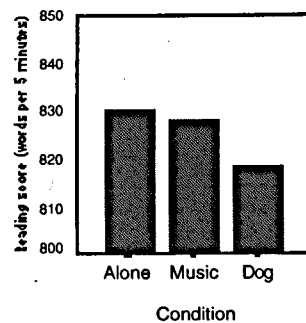
Note. *= $p < .05$ but $> .01$.

6.3.4 Task achievement

The issue of whether the dog or music conditions provided a distraction to the participants and might have lowered their stress in this manner was monitored by examining performance scores for the two tasks across conditions. Average score on the math task was 13.8 ($SD=5.2$) out of 20, and the average number of words read in five minutes was 825.2 ($SD=100.7$). There were no significant differences between the groups on either of these scores, see Figure 6.10.



$$F(2,77) = 0.10, p = .91$$



$$F(2,76) = 0.10, p = .90$$

Figure 6.10 Mean math and reading scores by group.

Note. Reading score excluded for one participant whose first language was not English.

To examine whether the physiological reaction to the reading task may have reflected vocal stylistics, the number of words read and reactivity to the reading task were correlated. The correlation between the number of words read and cardiovascular increases of systolic blood pressure $r = .04$, $n = 79$, $p = .73$, and diastolic blood pressure

$r=.17$, $n=79$, $p=.18$ were non-significant, although correlation with heart rate was significant, $r=.23$, $n=79$, $p=.04$. All correlations were positive with participants who read more words having higher reactivity.

6.4 Discussion

The aim of this study was to investigate the potential stress moderating effects of the presence of a companion animal. Specifically, the experiment incorporated a number of methodological improvements which have been lacking in previous studies and which might have mitigated against finding an effect. However the study demonstrated neither a main effect of companion animal presence reducing cardiovascular activity in comparison to an alone condition, nor a reactivity effect with companion animal presence moderating reactivity in comparison to an alone condition.

The previous companion animal research has produced mixed results: studies by both Friedmann *et al.* (1983b) and Locker (1985) found general activity in both baseline and task phases of their experiment was lower for the dog present period; Allèn *et al.* (1991) found that reactivity in the dog group was significantly lower than in an alone group but a number of studies have found no effect of dog presence (Grossberg *et al.*, 1988; Hansen *et al.*, in press; Nagengast *et al.*, 1997; Rajack, 1997; Straatman *et al.*, 1997). Therefore the results of the current study are congruent with some previous research and incongruent with other studies.

In terms of comparing a verbal and non-verbal task, similar non-significant effects were found with both. However, it was noted that heart rate reactivity was significantly related to the number of words read. This supports findings of Friedmann *et al.* (1982) who found higher cardiovascular reactivity when participants read at maximum tempo than normal tempo. Siegman, Dembroski and Crump (1992) also found that reading more slowly than normal was associated with lower reactivity

than normal tempo reading. This suggests that previous companion animal studies which failed to monitor the number of words read in their reading aloud tasks may have missed an important determinant of reactivity. Additionally it suggests that unless vocal stylistics can be carefully monitored or balanced, a non-verbal task is to be preferred.

Sebkova (1977) reported that her participants rated their anxiety as being lower in both a lab based and home based setting when a dog was present compared to a no dog condition. However there were no differences between the experimental groups in the current experiment on ratings of subjective anxiety. Straatman *et al.* (1997) using a similar design also found no effects on state anxiety levels. A number of studies on human social support have not found significant moderating effects on subjective measures of stress and anxiety even when cardiovascular effects are found (e.g. Christenfeld *et al.*, 1997; Gerin *et al.*, 1992; Glynn *et al.*, 1999; Kamarck *et al.*, 1990). Therefore it is not clear whether subjective effects would be seen in the absence of physiological effects. The only study on human social support to report significant effects on subjective indices is that of Gerin *et al.* (1995) which used a more sensitive within-subjects design. The magnitude of effect on subjective stress / anxiety measures seems much smaller and more difficult to detect. Alternatively this may reflect the fact as noted by other researchers (Gerin *et al.*, 1992; Lepore *et al.*, 1993; Sheffield & Carroll, 1996), that the subjective anxiety measures are taken at the end of the experiment and are thus retrospective in nature, whereas the cardiovascular measures are taken during the task.

The experiment did not find any differences between the control group and the music group. Music appears to hold a similar position to pets in that many people believe listening to music will be relaxing but physiological demonstrations of this in a laboratory setting are few and far between. Although some studies demonstrate higher levels of blood pressure and heart rate in response to exciting music than sedative music conditions (Gerra *et al.*, 1998; Iwanaga & Moroki, 1999), no other studies could

be found which compare effects of silence with music on cardiovascular acclimatisation to an experimental situation. Dobkin, Létourneau and Breault (1994) mention a conference presentation which suggested that a music waiting condition has comparable effects on resting blood pressure to a silent waiting condition, which suggests that music has no extra relaxing value. Similarly, only one study could be found which examined cardiovascular reactivity and music. Allen and Blascovich (1994) although claiming a moderating effect of music on cardiovascular reactivity, fail to report as significant an interaction between period (baseline versus task) and music condition. Therefore their results, as reported, do not show the effect they claim. It is unclear whether the non-significant findings in the current study represent an anomalous finding as concerns music literature. However, as far as this research is concerned, the issue of why there was no reactivity moderation from music is a peripheral issue compared to why the experiment failed to detect a stress moderation effect from the presence of the dog.

That the experiment did not find any significant condition effects, might suggest that there were serious design faults. However, the experiment did find a number of expected effects. Expected effects of participant's sex and age on cardiovascular variables were found (Matthews & Stoney, 1988). The stress tasks were successful in significantly raising the cardiovascular variables above baseline levels. Reactivity was comparable if not slightly higher than previous studies using a reading aloud task (Linden, 1987).

Therefore consideration should be made of the initial design set-up. It may be that there was no stress moderating effect, as the dog used in this study had no previous connection to the participants. However, two previous studies have found effects on cardiovascular variables using dogs unfamiliar to the participant (Friedmann *et al.*, 1983b; Locker, 1985). This suggests that these effects are not limited to situations where the person has had a prior relationship with the companion animal.

Other reasons why this experiment failed to find any effects may centre around the type of participant. Friedmann *et al.*, 's (1983b) initial effects were seen using child participants, Locker (1985) used young adults and Allen *et al.* (1991) used middle aged women. Therefore this effect would not appear limited to any one age group. Although the current study used a mixed sex sample, previous studies using mixed sex samples have found effects (cf. Friedmann *et al.*, 1983b; Locker, 1985). Considering the location of the study, Friedmann *et al.* (1983b) used a home setting, which although unfamiliar to the participants would have a fairly low level of formality, Allen *et al.* (1991) also used a home environment, however Locker (1985) found effects in a university laboratory. Therefore using a laboratory setting itself should not be a bar to finding effects.

Although each of the design choices does not in itself seem to be the reason why no effect was seen, it may be that a combination of these choices does not produce an effect. The only study to use the same combination of design choices was Straatman *et al.*, (1997) and they too found non-significant effects. However given that this combination represents a pragmatic and most feasible choice, other reasons which might mitigate finding any effects should be explored before rejecting the design.

Although a number methodological refinements were identified in section 5.3.2 which would reduce the extraneous variance in the measurement, certain of these were not applied in the current experiment due to the overlapping time scale of the literature review and data collection. There were no pre-experimental controls placed upon the behaviour of participants. This resulted in high levels of participants eating (75%) and consuming caffeine (35%) in a time frame likely to affect cardiovascular variables. Although only one person reported alcohol use, this was when considering the two hours prior to the experimental session, whereas current guidelines are to limit alcohol consumption for 12 hours prior to cardiovascular measurements. Although groups were balanced in these regards, this still represents a source of variance which could be reduced.

There was also no acclimatisation period prior to the baseline assessment. There are two main drawbacks to this: a) the notoriously unreliable first measurement, which reflects the novelty of the measurement technique, was incorporated into the first baseline estimate; b) the baseline measurement was probably too short to provide a stable level of baseline activity for many participants prior to the task. Supporting this suggestion, it can be seen that baseline systolic blood pressure measurements are markedly higher in the first half of the experiment than the second. These problems add extraneous variance to both baseline and reactivity measures which may make detection of a companion animal effect more difficult. Future studies should improve upon the baseline measurements and pre-experimental control of participants.

A final reason why the experiment failed to demonstrate an effect of the presence of a dog on cardiovascular reactivity to stressors is that perhaps the effect is not there to be found. However before concluding that previous positive findings are spurious, it is clearly important to further investigate methodological factors.

In conclusion, this experiment failed to provide support for the hypothesis that the presence of a companion animal either lowers general cardiovascular activity, reduces cardiovascular reactivity to a stressor or has an impact on self-report subjective anxiety. Although this study has methodological weaknesses, it suggests that this effect may not be free from contextual effects and artefacts and is not reliably produced. A number of explanations have been considered as to why an effect has not been found, these include lack of previous relationship with the dog, location of the study, choice of participants, lack of pre-experimental controls on participants and a poor baseline measurement technique. Of these, it is suggested that improvements to methodology may represent the most appropriate next step.

Chapter Seven

Experiment Two - Improvements in baseline measurement

7.1 Introduction

In the discussion to the previous experiment, a number of possible reasons were examined as to why a stress moderation effect of a companion animal was not found. The most plausible of these seems to be the methodological failings of the previous study in baseline measurement and pre-experimental control of participants' behaviour, as these are known ways of introducing extraneous variance into the measurement which may mitigate against finding effects. Therefore, the main aim of this experiment is to include a longer acclimatisation period to provide more reliable measures of both baseline and reactivity.

7.1.1 Acclimatisation issues revisited

As concluded in Section 5.3.2.3, many studies in the companion animal literature have used acclimatisation periods which seem too short to allow sufficient time for participants' cardiovascular levels to reach stable levels prior to determination of a baseline level. An unstable baseline measure is inherently unreliable and this unreliability is also passed on to the reactivity measure. A baseline assessed before a participant has fully acclimatised to an experimental situation is also likely to be inflated over true basal levels (Jennings *et al.*, 1992). Therefore if a stable baseline is not achieved for each person, comparison of reactivity scores across groups is less meaningful. For some participants, their observable reactivity will be under-estimated. The likelihood of making a type two error, failing to detect a real effect, is increased if the difference between rest and task levels is smaller than might be expected (Hastrup,

1986). This may explain why previous studies with short acclimatisation periods failed to detect reactivity or other effects. In fact the only study to report a significant reactivity effect had a ten minute acclimatisation period prior to baseline measurements (Allen *et al.*, 1991).

A short acclimatisation period is in itself a problem, but it is proposed that this may represent a particular confound in experiments using companion animals. The reasoning behind the proposal is this: *if* the presence of a companion animal causes participants to acclimatise to an experimental setting more quickly than participants in a control condition, *and* if a baseline measure is taken before all participants have fully acclimatised, *then* it is more likely that the dog present group will be fully acclimatised whereas the control group are less acclimatised. That the presence of a companion animal might cause people to acclimatise to an experimental setting more quickly is plausible, as there are many claims that the presence of an animal makes a situation less stressful.

An illustration of these hypothetical events can be seen in Figure 7.1 which depicts changes in a cardiovascular variable over a rest period in a hypothetical dog-present group and a control group. It is presumed that both dog and control groups will have a similar entering level of cardiovascular activity. If the presence of a dog causes people to relax more quickly, then this group's cardiovascular levels would decline more quickly than the control group's levels. Presumably, the final resting levels of both intervention and control groups would be the same. However if a baseline estimate is taken before cardiovascular activity has stabilised, then this would seem to produce lower baselines for the dog group than the control group.

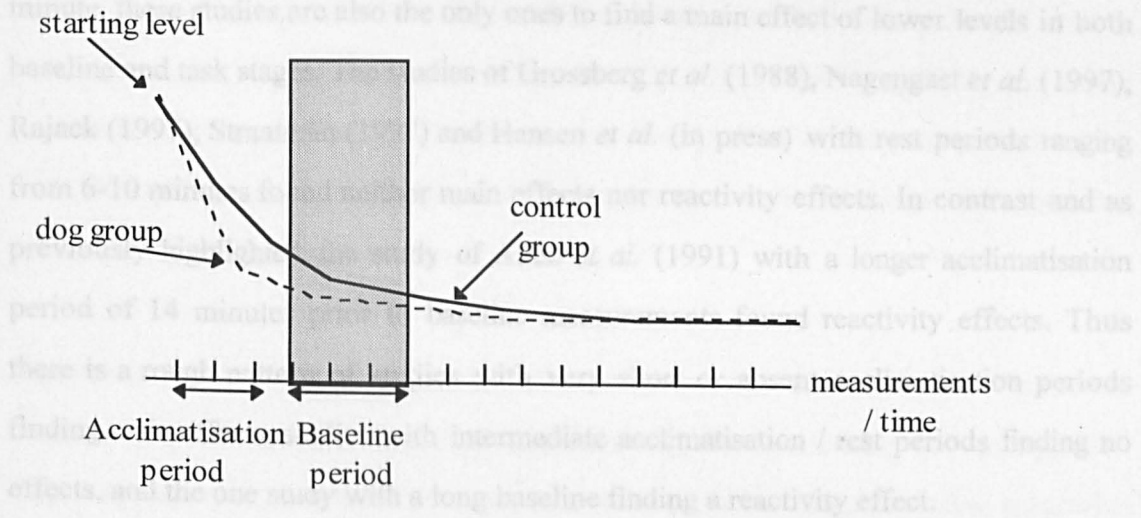


Figure 7.1 Illustration of the effect of estimating a baseline before a stable level of activity has been reached.

According to the law of initial values (Wilder, 1967), people tested closer to their true basal levels will evidence larger reactivity than if they are already partly stressed. Therefore a fully acclimatised dog present group would be expected to have greater reactivity than a less acclimatised control group. This would suggest that the dog present group should have higher reactivity than a control group. However, if the presence of the dog also decreases reactivity due to some other stress moderation mechanism, then these two antagonistic effects may cancel each other out. This would result in similar reactivities for both groups, but the dog group's baseline level being lower, so that levels in both baseline and task periods would be lower for the dog group. This would be reflected in a main effect of dog presence in an analysis of baseline and task levels. Therefore, studies with short baselines may be prone to finding either no effects or main effects whereas studies using an adequate acclimatisation period may be more likely to find reactivity effects.

Examination of the mixed results of the earlier companion animal studies supports this hypothesis. The studies of Friedmann *et al.* (1983b) and Locker (1985) used the shortest rest periods of 2-3 minutes, with either no acclimatisation time, or only one

minute, these studies are also the only ones to find a main effect of lower levels in both baseline and task stages. The studies of Grossberg *et al.* (1988), Nagengast *et al.* (1997), Rajack (1997), Straatman (1997) and Hansen *et al.* (in press) with rest periods ranging from 6-10 minutes found neither main effects nor reactivity effects. In contrast and as previously highlighted, the study of Allen *et al.* (1991) with a longer acclimatisation period of 14 minutes prior to baseline measurements found reactivity effects. Thus there is a rough pattern of studies with very short or absent acclimatisation periods finding main effects, studies with intermediate acclimatisation / rest periods finding no effects, and the one study with a long baseline finding a reactivity effect.

However, to fully examine this hypothesis, one needs to examine the rate of decline in a control and dog present group over a sufficient time period. Therefore one aim of the current experiment is to examine whether there is differential adaptation to an experimental situation in a condition with a companion animal present as opposed to a control condition.

There appear to be two main methodological issues in assessment of baseline levels. Firstly allowing a sufficient time for cardiovascular variables to be at a near basal level, and secondly taking enough measurements after this point to reliably assess levels. There are a number of recommendations as to how long should be allowed for acclimatisation. How many measurements to then take would appear to be a question addressed by application of generalizability theory to cardiovascular measurement (Llabre *et al.*, 1988). Llabre *et al.* found within sessions reliability to be over .90, with two measurements of systolic and diastolic blood pressure. Although this contrasts with guidelines of Shapiro *et al.*, (1996) of three or more measurements.

In preparation for this experiment, a review was made of current practice in mainstream cardiovascular reactivity research for determining a stable baseline level of activity. There are many techniques currently used. The most common choice is a acclimatisation / rest period of fixed duration, however, the most appropriate time

length required has not yet been agreed. When Hastrup (1986) surveyed 114 studies published in the journal *Psychophysiology* in 1978, 1980, 1982 and 1984, she found that baseline adaptation periods (measured as the duration of the rest period to the mid-point of the baseline period) varied from a few seconds to 30 minutes, or a baseline taken on a separate non stress day.

Hastrup correlated the baseline adaptation time period with the mean heart rate obtained and found that there was a significant negative relationship ($r = -.64, p < .01$). This suggests that measures from studies with a shorter baseline were somewhat confounded by a lack of adaptation of the participants. Based on finding that the studies in her sample with the longer baseline adaptation periods of 15 minutes or more had lowest baselines, Hastrup (1986) suggested that a period of at least 15 minutes is required to allow heart rate to reach true basal levels. Dobkin, Létourneau and Breault (1994) concur with this in their comparison of various fixed length heart rate baseline measures and suggest at least 15 minutes of acclimatisation prior to baseline heart rate measures is required. This recommendation was based on their findings that a baseline based on minutes 7, 8 and 9 of the rest period was significantly higher than one based on minutes 13, 14 and 15. However, it should be noted that their analysis does not examine the change between levels at 9 minutes and those later in the series.

For blood pressure measurements, Shapiro *et al.* (1996) in their publication guidelines for the journal *Psychophysiology*, suggest allowing at least 20 minutes, for the participant to acclimatise to the experimental environment, prior to baseline measurements. They do not give an indication on what evidence this is based, although these are guidelines of a panel of experienced researchers. In contrast, two studies which explicitly analysed data over a rest period suggest acclimatisation periods of less than 10 minutes. Goodman, Dembroski and Herbst (1996) found stable blood pressure baseline levels, in their sample of male normotensive undergraduates, after 6.5 minutes acclimatisation and five cuff inflations. This recommendation was based on comparison of successive systolic blood pressure baseline estimates, which they found not to differ

significantly after 6.5 minutes. The analysis of Jennings *et al.* (1992) was based on comparisons of the within baseline standard deviation of measurements and generalizability comparisons. They compared 20 minute and 10 minute rest periods and suggest no advantage of the longer time length. Thus the guidelines for the required duration of a fixed length baseline do not converge on any one value.

An alternative to the fixed length baseline is to tailor baseline periods for each participant based on the coefficient of variation of measurements. Blood pressure is unlikely to reach a completely stable level even in a careful research setting and the expected standard deviation for minute to minute readings of systolic blood pressure is about 4 mmHg and for diastolic about 2 to 3 mmHg (Reeves, 1995). Contrada, Wright and Glass (1984) used a tailor made baseline in their experiment: Participants were given up to 15 minutes to rest prior to the stressor, baseline was considered the average of two measurements, taken after a minimum of seven minutes, which differed by less than 5 mmHg systolic blood pressure. The procedure of Contrada *et al.*, (1984) allows the experimental procedure to be shorter for those participants who seem to adapt more quickly and thus reduces the likelihood that participants will get bored before the end of the measurement period. However, despite its obvious advantages, this procedure has not been widely adopted and it is unclear what effect varying rest periods have on the subsequent reactivity to the task.

The separate day baseline was advocated by Obrist (1981). The rationale behind this technique is that anticipatory stress on the day of testing may prevent participants from reaching a basal level of cardiovascular activity prior to the stressor. This would mean that although a participant might reach a stable level, this represents a stable level of arousal prior to the stressor and not a resting baseline close to basal levels. This technique has also not been widely adopted, with only three in the journal *Psychophysiology* from 1986 to 1992 using a separate baseline (Jennings *et al.*, 1992). Obrist, Light, James and Strogatz (1987) found that a separate day 15 minute baseline produced lower heart rate (2 bpm) but higher systolic and diastolic blood pressure (1

mmHg) than a pretask 15 minute baseline. Miller and Ditto (1991) also found little or no difference between a 1 hour same day baseline and a pretask baseline. A later study by Dobkin *et al.* (1994) found that a 15 minute separate day baseline was rated as aversive by bored participants, that heart rate started to rise towards the end of this rest period and that measurements were not significantly different from a baseline taken prior to task presentation. Thus it would seem that the separate day baseline does not offer a solution to problems of obtaining a basal measure and does not warrant the extra effort of testing subjects on two separate occasions.

In contrast to a separate day baseline, a post-stress baseline has been advocated (Dobkin *et al.*, 1994; Shapiro *et al.*, 1996). This retains much of the rationale of the separate day baseline, in that subjects are made aware that no further stressors are to be anticipated. However it has advantages in allowing researchers to complete measurements in one session. Dobkin *et al.* found a post-stressor baseline to be significantly lower than a baseline taken after a fixed length 13 minute acclimatisation period.

An alternative development by Jennings and colleagues (1992) is the so called '*vanilla baseline*'. The vanilla baseline aims to keep the participant at a minimal but stable level of physiological activity. To do this the participant is given a simple colour detection task to occupy them during the acclimatisation period. Jennings *et al.*, concluded that the vanilla task could produce a more consistent state than a standard rest condition over a 10 minute period. However, the results produced for the vanilla and standard 10 minute baselines were similar and it is arguable whether the advantages gained by using this technique are justified for the extra difficulty in setting up a suitable 'baseline task'.

In conclusion, there seems to be no current consensus as to the best practice in this area. Although the articles by Hastrup (1986) and Jennings *et al.*, (1992) have highlighted the problems in this area, both suggest that more research needs to be

carried out to compare various techniques for assessing baseline cardiovascular activity. Therefore a further aim of this experiment was to generate data which could be examined for guidance on the best duration for an acclimatisation period.

In the current study, it was decided to use a fixed length acclimatisation period of 14 minutes of measurements prior to baseline measurements which would be over a further 6 minutes. This is shorter than the 20 minutes advocated by Shapiro *et al.* (1996) but more in line with conclusions of Jennings *et al.* (1992) and Goodman *et al.* (1996) in their direct comparisons of blood pressure acclimatisation periods which suggest time lengths of less than 10 minutes are adequate, and approximate to the recommendations of Hastrup (1986), Dobkin *et al.* (1994) for 15 minutes acclimatisation prior to heart rate measurements. This allows a 20 minute period over which trends in cardiovascular variables can be monitored for subsequent analysis of how long is required for acclimatisation.

7.1.2 Examination of mechanisms occurring in companion animal experiments

In addition to the baseline issues, a second strand to this experiment concerns exploration of some of the mechanisms, which may underlie any stress moderation from the presence of a companion animal. In this experiment a preliminary examination will be made of whether the presence of a dog reduces the threat of the experimental situation.

Reduction of perceived threat of the experimental situation, was proposed as a mechanism which may result from the presence of a companion animal and which might account for the reduction in cardiovascular activity found by Friedmann *et al.* (1983b) in their study. Supporting this suggestion, Lockwood (1983) found that inclusion of a dog in a line drawing resulted in lower formality ratings. It has been established in main stream cardiovascular research that a high threat situation produces larger reactivity (Gerin *et al.*, 1995; Kamarck *et al.*, 1995). However none of the studies

which have exposed participants to the same setting with and without a dog have measured perceived threat levels. Therefore it is uncertain whether social threat is diminished by the presence of a dog and whether this leads to reduced cardiovascular activity or reactivity.

7.1.3 Other methodological issues

In addition to baseline issues, as an improvement over the previous study, subjects were asked to restrict their smoking, caffeine and alcohol use in line with the instructions of Shapiro *et al.* (1996). They suggest restrictions of 2 hours nicotine abstinence, 3 hours caffeine abstinence and 12 hours alcohol abstinence.

Shapiro *et al.* do not give precise guidelines for restriction of food and fluid intake or exercise although they note that these factors may have chronic effects on cardiovascular variables. Therefore, eating and drinking were also restricted for 2 hours prior to the experimental session. The study by Goldstein, Shapiro and Hui (1995) suggests that in young participants (20-39 years), alterations in blood pressure following a meal are complete after 2 hours. Although heart rate increases may be evident after two hours, it was felt that restricting food intake for longer than 2 hours would not be possible in this non-captive population. In mitigation of this strategy, food intake has not been found to affect reactivity to stress tasks and its magnitude of effect on baseline cardiovascular levels is small (Sheffield *et al.*, 1997).

Social interaction between the experimenter and participant was standardised by using a script. As the previous experiment had revealed that it was impossible to standardise the initial greeting phase, this part of the experiment was tape recorded to allow further and independent analysis of the greeting phase content. In addition, taping allowed external confirmation of adherence to the script. A two stage design was used so that all participants were introduced to the experimenter in the same neutral surroundings. Any interaction occurring before the script started during the greeting would not be

attributable to the treatment (music or dog) as all participants would be in the same neutral surroundings and the script would be established before participants were moved into the treatment surroundings. Participants were fore-warned that the experiment was investigating stress responses in different environments and therefore they should not comment on the surroundings in the experimental room.

As the focus of this study was not on task comparison, only one task was used. Given the concerns surrounding verbal tasks and as the previous study had found some suggestion that reactivity was affected by vocal stylistics, a non verbal task was used.

7.1.4 Summary of design

Design choices made prior to the first experiment regarding nature of participants, location, exposure to dog design and companion animal were retained. These were pragmatic choices and are not easily varied. Therefore, the experimental design was similar to the first experiment with three conditions: a control condition with only the experimenter present, a music condition where relaxing music was playing, and a dog condition where the same dog as in the first experiment was settled in the room. A 20 minute rest period would be allowed to examine trends in cardiovascular variables and assist in determining the most appropriate acclimatisation period. To ensure, as far as feasible, that baseline levels had been reached, a 14 minute acclimatisation period would be allowed prior to baseline measures. Other methodological refinements included explicitly asking participants to refrain from behaviours which might have carry-over effects onto cardiovascular baseline or reactivity levels in the experimental session. Improvements were also made to the handling of the greeting phase of the experiment to exclude any effect that the treatments might have on this phase and subsequent reactivity. Perceptions of threat and threat of the experimental session were assessed to examine if the presence of a dog reduces formality or other aspects of a setting and thus may affect reactivity.

7.2 Method

7.2.1 Participants

The number of participants for the experiment was determined by power considerations. For an 80% likelihood of detecting a large effect, in an ANOVA with three groups, using a two tailed test with α of .05, a minimum of 21 participants per group were required (Cohen, 1992).

The participants for the experiment were 75 adults, predominantly postgraduate university students recruited by poster campaign. There were 33 males and 42 females, aged 18-41 years, mean 24 years ($SD=5.7$ years). None of the participants knew the experimenter before the study. Participants were asked by letter before they took part in the experiment to refrain from: a) eating, drinking or smoking, for 2 hours prior to the experiment; b) ingesting caffeine, or taking strenuous exercise for 3 hours before the experiment; and c) taking alcohol for 12 hours prior to the experiment. Compliance with these restrictions was assessed by self report questionnaire. Participants did not report any heart or circulatory conditions or any condition which might put them at risk from repeated blood pressure measurements. In addition, checks were made that participants were not using medication which may affect the cardiovascular system. Participants were paid £2.50 expenses or given course credit for taking part.

The experiment incorporated three between-subjects conditions: a) a control condition where only the experimenter was present, and two other conditions involving the addition of either b) a dog present or c) relaxing music playing. One stress task was used. For each sex, participants were allocated to the dog condition or non-dog condition within the availability of the dog, but between non-dog conditions, control and music, randomly.

7.2.2 Task

One stress task was used in this experiment. The task was a non-verbal, time pressured, mental arithmetic test. In contrast to the first experiment which used non-academic university employees, the participants for this study were predominantly university students. Therefore, the math tasks was changed to make it more difficult than the task used in experiment 1. The maths test consisted of 24 questions with a variety of addition, subtraction, multiplication and division terms, see Appendix F. The answers produced were a mixture of positive and negative numbers.

Some researchers advocate using tasks which adjust to the capabilities of the participants to ensure a success level of 60% (Kamarck, 1992). It is reasoned that intermediate levels of difficulty will keep engagement high and produce greater reactivity than either a very easy or difficult task (Tomarken, 1995). It was not possible within the constraints of equipment and experimenter skill, to design a maths task which evaluated participants' performance and adjusted the difficulty of maths questions during the test. However, in the task used, seven questions were designed so that there were two possible answers depending on whether people use a) correct mathematical strategy of performing multiplication and division processes first, followed by addition and subtraction processes, or b) a simpler strategy of working through terms from left to right. The questions were devised such that the former strategy results in a more difficult question. For example:

question: $22-18 \times 25-3$

Formal strategy: first multiply 18 by 25 (=450), then subtract this from 22 (= -428) then subtract -428 a negative from a negative -3, produces a final answer of -431.

Simpler strategy: subtraction of 18 from 22, gives an answer of 4, multiply this by 25 to give 100 and then subtract 3 produces a final answer of 93.

The people more competent in maths might be expected to use the formal strategy and would find the questions more difficult than those using the simpler strategy. The task was piloted and revised until most participants achieved 14/24, 60% correct answers.

The problems were each presented for 15 seconds on a computer screen and participants were required to write their answers on an answer sheet. No feedback was given during the course of the test. Answers were scored as correct using either strategy. The number of correct answers was noted.

7.2.3 Apparatus

An Apple Macintosh IIfx computer was used to present the stress task and Critikon Dinamap 8100 was used to monitor cardiovascular variables. A portable battery powered tape recorder (Philips N2235) was used to record the social interaction between participant and experimenter during the experiment.

7.2.4 Measures

7.2.4.1 Demographic questionnaire

The demographic questionnaire asked for participants age, gender, weight and height for calculation of a body mass index, and their family history of hypertension. In addition to sex and age, as assessed in experiment one, body mass index (BMI) and family history of hypertension are regarded as factors influential on blood pressure which should be checked to ensure experimental groups do not differ on them (Shapiro *et al.*, 1996). Participants were also asked their attitude towards dogs using the same 7 point scale used in experiment one. All participants were asked this question prior to them seeing the dog to avoid the answers of those in the dog condition being biased after sitting through an experiment with a well behaved dog. Pet ownership status was also noted. A copy of the questionnaire can be seen in Appendix G.

7.2.4.2 State-trait Anxiety Inventory

Form Y of the state-trait anxiety inventory was again used (Spielberger, 1983). In this experiment, the participants completed the trait anxiety inventory prior to exposure to the experimental condition to exclude any effect that this might have on the participant's anxiety. The state inventory was given after the task.

7.2.4.3 Experimental assessment questionnaire

A number of potential explanations were suggested for why the presence of a dog might lead to lower reactivity in section 5.3. A preliminary questionnaire was designed to investigate relevant aspects which might distinguish the experimental groups and suggest that certain mechanisms were occurring. To check whether the experimental conditions differed in threat, participants were asked to rate the experimental setting on pleasantness, seriousness, formality, laxness and how important they felt the experiment was. To check whether the experimental conditions affected the perception of the experimenter, participants were asked to rate the experimenter on her manner, reassuring to intimidating. To check for distraction, participants were asked to rate their perceived ability to concentrate on the task. As a check on participants' comfort, they were asked to rate the comfort of wearing the monitor. All aspects were rated on a 6 point bi-polar scale. A copy of the questionnaire can be seen in Appendix H.

7.2.4.4 Pre-experimental behaviour questionnaire

Participants were asked: not to consume food or fluid or to smoke for 2 hours prior to the experimental session; not to consume caffeine or take strenuous exercise for 3 hours prior to the experimental session; and not to consume alcohol for 12 hours prior to the experimental session. The questionnaire used to check this behaviour is shown in Appendix I. Participants were also asked to rate the amount of stress in their lives over the past two weeks on a 5 point scale, intense stress, a lot of stress, tolerable stress, very little stress and no stress. Smoking status was assessed with the question, regular

smoker: yes or no.

7.2.5 Procedure

Participants were greeted in an ante-room, with minimal social interaction. At this stage the script was established and recording of the session on tape was started to enable the levels of any interaction to be assessed. The participant was given the demographic and trait anxiety questionnaires to fill in. In the initial briefing, the participant was cautioned not to comment on anything in the experimental room, and not to talk when the blood pressure measurements were taking place.

When the participant had completed the first questionnaires, they were taken into the experimental room. The set-up for the treatments was as before, with the dog on a bean bag about 15 feet away from the participant. The participant could easily see the dog from their chair. The same male Brittany Spaniel was used as in experiment 1. The music was a collection of Baroque music (Castle Communications, 1995) played at a soft volume. The music was selected using the same criteria as for experiment 1, although a change in music was used for the experimenter's comfort. Features such as tempo, rhythm and instruments played were considered and determined likely to produce a relaxed atmosphere. The participants could not see or hear the music or dog whilst in the ante-room. No participants made any reference to either the dog or music during the experiment.

A diagram of the procedure is given in Figure 7.2.

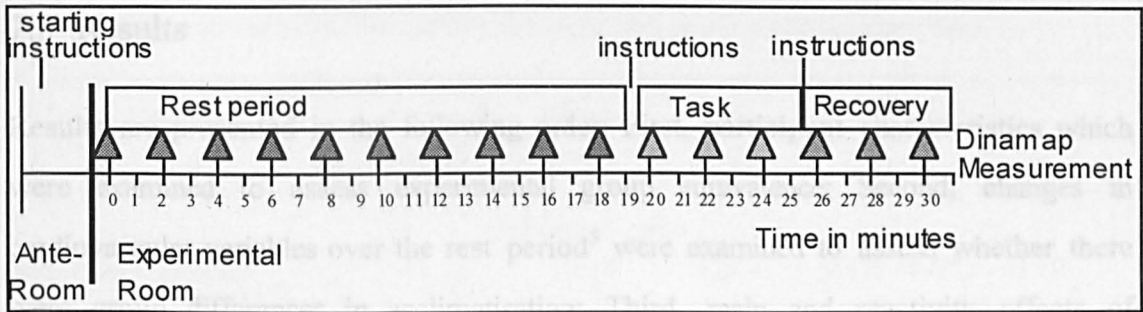


Figure 7.2 Plan of procedure in experiment two.

As soon as they entered the experimental room, participants were seated in front of the computer and the monitor fitted to their non-dominant arm. The Dinamap took measurements at two minute intervals throughout the measurement period. The first measurement period was a 20 minute rest period where participants were asked to sit quietly and ten measurements were taken. The rest period could be divided into an acclimatisation period lasting 14 minutes and a baseline period of 6 minutes. Measurements in the baseline period were taken 14, 16 and 18 minutes into the rest period. This was followed by a six minute maths task, with measurements taken at 0:30, 2:30 and 4:30 minutes into the task. Participants were then informed that there were no further stress tasks but they were asked to sit for a further five minutes whilst three measurements were taken to reflect their post stress levels. Readings were taken 0:30, 2:30 and 4:30 minutes into the recovery period.

After the measurement phase had been completed, the pressure cuff was removed and participants were asked to complete the state anxiety, experimental assessment and pre-experimental behaviour questionnaires. At the end of the experiment, the participants were debriefed and allowed to ask any questions or make comments regarding the procedure. The participants were then paid. Total testing time for each participant was about 50 minutes.

7.3 Results

Results are presented in the following order: First, participant characteristics which were examined to assess experimental group equivalence; Second, changes in cardiovascular variables over the rest period⁵ were examined to assess whether there were group differences in acclimatisation; Third, main and reactivity effects of experimental conditions were examined; Fourth, subjective anxiety and its relationship to physiological data; Fifth, task achievement; and finally, subjective evaluations of aspects which might be altered by the presence of a dog or music.

7.3.1 Participant characteristics

Analyses of variance and chi-square tests were used as appropriate to examine whether participants differ in important aspects across groups, see Table 7.1. All quantitative variables for which parametric tests were run met assumptions of normality and homogeneity of variance. An alpha level of .05 was set for all statistical tests.

There were no significant differences between the groups on their age, BMI⁶, trait anxiety score, prior life stress rating, attitude towards dogs and resting blood pressures and heart rate. Trait anxiety levels were slightly higher than norms given by Spielberger (1983) for American college students of 38.3 for males and for females 40.4. In the current experiment, the mean for males was 40.4 ($SD=10.9$) and for females 45.5 ($SD=12.8$). Distributions of males and females, and family history of hypertension per condition were even. Therefore it was concluded that experimental groups were equivalent with regard to major characteristics.

⁵ The rest period is the entire time prior to the task. This includes both acclimatisation period and baseline period.

⁶ BMI weight (kg) / height (m) ²

Table 7.1 Group variations in salient demographic and attitudinal variables.

Variable	Control <i>n</i> =25	Music <i>n</i> =24	Dog <i>n</i> =26	Analysis
dichotomy ratio				
Sex. (male: female)	11:14	10:14	12:14	$\chi^2(2, N=75) = 0.10$, $\phi=.04, p=.95$
Regular smoker (yes:no)	3:22	5:19	6:20	$\chi^2(2, N=75) = 1.14$, $\phi=.12, p=.57$
Family history of hypertension (yes:no)	13:12	11:13	14:11 ^c	$\chi^2(2, N=74) = 0.51$, $\phi=.08, p=.77$
means (standard deviation)				
Age (years)	23.6 (5.1)	24.3 (6.5)	24.1 (5.7)	$F(2,72) = 0.08$, $R^2<.01, p=.92$
BMI	22.5 (3.7)	21.9 (3.6)	22.3 ^a (2.3)	$F(2, 71) = 0.21$, $R^2<.01, p=.81$
Trait anxiety ^b	43.0 (9.7)	41.8 (10.4)	42.9 (9.2)	$F(2,66) = 0.11$, $R^2<.01, p=.90$
Prior stress ^d (1= intense, 2= a lot, 3= tolerable, 4= very little, 5= none)	2.7 (0.8)	2.7 (0.8)	2.7 (0.9)	$F(2,63) = 0.04$, $R^2=.01 p=.96$
Attitude towards dogs (1= dislike dogs intensely, 7= like dogs intensely)	4.6 (1.8)	4.5 (1.5)	4.8 (1.7)	$F(2,72) = 0.17$, $R^2<.01, p=.85$
Baseline systolic blood pressure (mmHg)	115.4 (10.0)	113.4 (10.8)	113.5 (10.0)	$F(2,72) = 0.23$, $R^2<.01, p=.80$
Baseline diastolic blood pressure (mmHg)	64.9 (7.5)	63.8 (9.5)	65.6 (7.3)	$F(2,72) = 0.31$, $R^2<.01, p=.74$
Baseline heart rate (bpm)	71.2 (9.8)	73.0 (8.5)	73.9 (9.8)	$F(2,72) = 0.54$, $R^2=.02, p=.58$

Note. a= missing data on BMI for 1 participant.

b= missing data on more than one item on trait anxiety scale for 6 participants, 2:3:1 for control, music and dog conditions respectively.

c= missing data on family history of hypertension for 1 adopted participant.

d= missing data on prior stress scale for 5 participants, 2:2:1 for control, music and dog conditions respectively.

Adherence to pre-experimental controls on previous smoking, eating and alcohol use prior to the experiment was fairly good. Frequencies of non-adherence were low and evenly spread between groups, see Table 7.2.

Table 7.2 Adherence to pre-experimental controls

Restriction time frame	Able to adhere (yes : no)			Analysis
	Control <i>n</i> =25	Music <i>n</i> =24	Dog <i>n</i> =26	
Eating < 2 hours	16:9	18:6	21:5	$\chi^2(2, N=75) = 1.88$, $\phi=.16, p=.39$
Smoking < 2 hours	25:0	23:1	26:0	$\chi^2(2, N=75) = 2.15$, $\phi=.17, p=.34$
Caffeine < 3 hours	21:4	21:3	26:0	$\chi^2(2, N=75) = 4.27$, $\phi=.24, p=.12$
Strenuous exercise < 3 hours	23:2	23:0	24:1	$\chi^2(2, N=73) = 1.95$, $\phi=.16, p=.38$
Alcohol < 12 hours	23:2	24:0	24:2	$\chi^2(2, N=75) = 1.99$, $\phi=.16, p=.37$

Note. Missing data on previous exercise behaviour for 2 participants.

7.3.2 Analysis of rest period data

7.3.2.1 Analysis strategy

Preliminary examination of graphs of rest period levels suggested that the change over the period was not similar for all variables, therefore it was decided to analyse data for each cardiovascular variable separately.

First an ANOVA was performed on the 10 measurements gained during the rest period. GROUP (control, music, dog) was included as a between-subjects variable, with TIME (10 levels) used as a within-subjects variable. The point of interest was the interaction between TIME and GROUP, which would indicate if there was a different profile of variation between the groups. A main effect of GROUP was not anticipated, as

previous analyses, see Table 7.1, had shown that baseline estimates derived from the end of the rest period did not differ between groups. A main effect of TIME was expected, reflecting the change in variables over the rest period.

To give guidance on how long an acclimatisation period is required, linear, quadratic and exponential curves were fitted to the group data. This provides estimates of expected levels at various stages of the rest period and eventual levels. Stability of successive measurements in the rest period was examined, as a baseline estimate should not just be low, but also a stable level of activity. A similar analysis was performed to that used by Jennings *et al.* (1992), where stability was assessed by computing a temporal stability index based on the within baseline standard deviation of measurements. Finally, to replicate the analysis of Goodman, Dembroski and Herbst (1996), successive baseline estimates derived from three measurements were compared to see at what point there is no statistically significant change in the measured baseline.

7.3.2.2 Systolic blood pressure

Figure 7.3 shows the decline in systolic blood pressure during the rest period.

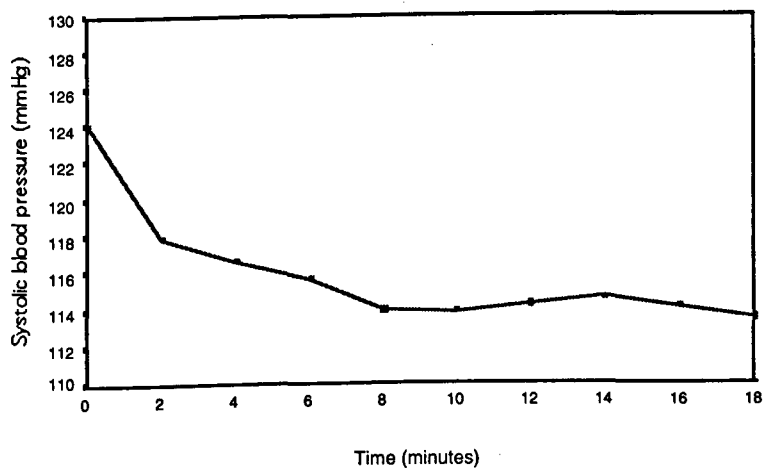


Figure 7.3 Mean levels of systolic blood pressure over the rest period

7.3.2.2.1 ANOVA

As expected, the main effect of GROUP was non-significant $F(2,72) = 0.15, p=.86$. TIME as expected was a significant factor, $F(9,648) = 38.77, p<.01$, demonstrating that systolic blood pressure levels varied significantly over the analysis period. The non-significant interaction between time and group $F(18, 648) = 0.99, p=.47$, showed that the variation over the rest period did not differ by experimental group of participant.

7.3.2.2.2 Curve fitting

Visual inspection of the graph suggested that systolic blood pressure levels decrease in an exponential manner. This is supported by Table 7.3, showing the results of testing for linear, quadratic and exponential trends, in which it can be seen that the data best fit an exponential curve. The exponential model explains the greatest amount of variance in the data. Functional form tests were significant for the linear and quadratic models, suggesting that these models are not a good fit, whereas the exponential model was non-significant, i.e. a good fit.

Table 7.3 Curve fitting for systolic blood pressure rest period data.

Curve	Model	r^2_{adj}	a	b	c
Linear	$y = at + b$	.55	-0.42 (0.12)	119.63 (1.27)	-
Quadratic	$y = at^2 + bt + c$	.84	0.06 (0.01)	-1.41 (0.26)	122.27 (1.02)
Exponential	$y = ae^{(bt)} + c$	.97	9.98 (0.58)	-0.39 (0.05)	114.05 (0.26)

Note. Values with standard errors shown in parentheses. All components make significant contributions to their respective models.

a, b, and c have different physical interpretations across models,
t= time in minutes, y= heart rate bpm, e= exponential constant

An exponential decay is seen in other physiological parameters after physical exercise (Oosthuyse & Carter, 1999; Pinkowski, Mohr, & Krzywanek, 1998), and is consistent with descent towards a stable level.

The parameter estimates for the exponential curve suggest that eventually, systolic blood pressure tends to 114.05 mmHg. Exponential decay would imply that the longer one measures, the closer the measured levels should be to the limiting value, however in practice, after a certain point, the levels are so close that further measurements will not observe a meaningful decline in levels. Meaningful decline can be considered in either absolute or relative terms. It can be calculated that after 7 minutes 39 seconds, the group systolic blood pressure would only decrease on average by 0.5 mmHg, not a meaningful amount and a difference not discernible with the Dinamap (which gives measurements to the nearest whole number). Another way to view this is to consider the percentage adjustment over time. A general guide might be to measure baseline after 95% of the theoretical decay has occurred. By rearranging the exponential curve formula, the value for time (t) for k% of the theoretical decay to take place is obtained:

$$t = \frac{1}{b} \log_e \left(1 - \frac{k}{100} \right)$$

Applying this formula to the current data set, suggests that 95% of decay occurs after 7.66 minutes, 7 minutes, 40 seconds and therefore measuring after this point would only capture an additional 5% of the theoretical decay.

Although the averaged data give an excellent exponential fit, the fit for individual participants is much less impressive because of the high level of noise present in the individual's trace. This is not surprising, as it might expected that acclimatisation is not a smooth process but rather is punctuated by random events which may produce momentary increases in physiological arousal. Although, the limitations of the measurement equipment preclude such an analysis. Intermittent measurement

techniques such as the Dinamap at two minute intervals, give a poor resolution of only ten data points across a 20 minute period. Hence it is not possible to model decay curves for the individual participants, so it is not certain that the systolic blood pressure levels for an individual participant will decrease in an exponential form. Presumably for individual participants, the decay rate and eventual level differ and thus the point after which meaningful decay does not occur may be quicker or slower. A continuous measurement technique would be essential to gain a greater understanding of an individuals blood pressure decay profile. However within this sample sex differences were explored by attempting to fit exponential curves to the two averaged data sets. Exploration of age differences was not possible in this sample, as the majority of subjects were 20-25 years. However curve fitting which was performed on samples from other experiments in the research series which have a wider age range is shown in Appendix J.

Table 7.4 Exponential curve fitting for male and female systolic blood pressure data.

Dataset	r^2_{adj}	a	b	c	8 minute value	95% decay time
Males	.94	11.11 (0.91)	-0.38 (0.06)	120.79 (0.41)	121.34	7:57
Females	.96	9.10 (0.59)	-0.41 (0.07)	108.76 (0.25)	109.11	7:21

Note. Values with standard errors shown in parentheses.
a = decay over time, b = rate of decay and c = final limiting value,

Curve fitting to the datasets for the two sexes is shown in Table 7.4. In both cases, the exponential fit to the averaged data was excellent. This suggests that although both samples reach a 95% decay point by 8 minutes, males take slightly longer than females, this difference may not be meaningful. Reflecting epidemiological differences, the final limiting value is higher for males than females. The difference between the final limiting value and the fitted level at 8 minutes is 0.35 mmHg for females and just over this at 0.55 for males. Therefore the conclusion from exponential curve fitting is that allowing

8 minutes is sufficient length of time to capture the majority of decay that is going to occur in young participants prior to baseline measurements.

7.3.2.2.3 Stability

Although a low measurement is to be preferred, as this supposedly is closer to a true basal level of activity, an equal goal is to gain a stable measurement. A low group average may hide a lot of individual instability. The magnitude of change for each participant between successive systolic blood pressure measurements is shown in Figure 7.4. As can be seen, the readings are more unstable during the beginning part of the measurement period and appear to be becoming more stable towards the end of the rest period. From these data, it would appear that a longer time would lead to a more stable baseline estimate. There do not seem to be any guidelines as to how stable a measurement should be before baseline estimates are taken. However, Reeves (1995) does suggest that expected minute to minute variation of systolic blood pressure is 4 mmHg. Measures in this dataset are below this level after 10 minutes.

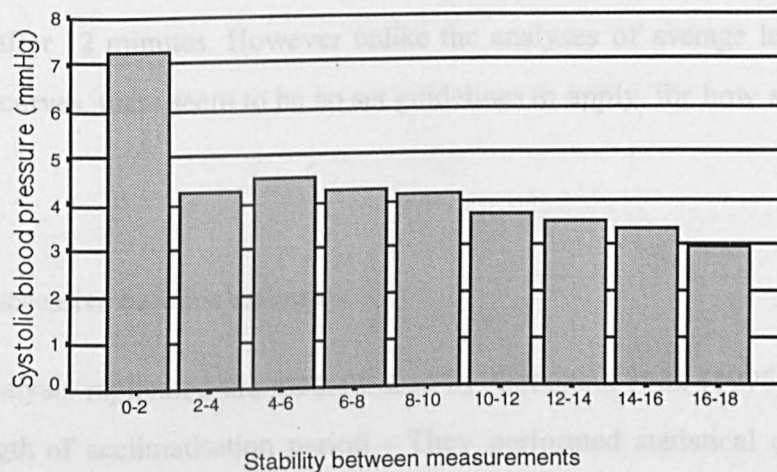


Figure 7.4 Magnitude of change between successive two minute measurements of systolic blood pressure

Replicating the analysis of Jennings *et al.* (1992), the temporal stability of each successive potential baseline estimate was calculated, this is equal to the within baseline standard deviation. Temporal stability indices were congruent with the trends shown in Figure 7.4, these decrease across the rest period.

Table 7.5 Temporal stability of successive systolic blood pressure baselines

Baseline derived from measurements in these minutes of the rest period	Temporal Stability
0,2,4	3.94
2,4,6	2.62
4,6,8	2.79
6,8,10	2.64
8,10,12	2.43
10,12,14	2.40
12,14,16	2.05
14,16,18	2.13

Temporal Stability = within baseline standard deviation.

The conclusion from stability calculations is that the longer one measures, the more stable measurements become, although there is a slight indication that the stability 'stabilises' after 12 minutes. However unlike the analyses of average levels based on exponential curves, there seem to be no set guidelines to apply for how stable is stable enough.

7.3.2.2.4 Successive baseline estimates

A further analysis replicated the method used by Goodman *et al.* (1996) to determine required length of acclimatisation period - They performed statistical comparison of successive baseline estimates and determined that acclimatisation levels had been reached when successive baseline measures did not differ significantly. In statistical terms, there is no point in measuring for longer when there is no statistical change in the values gained. Successive baselines differed at $p < .05$ until the comparison of baselines derived from minutes 8,10 and 12 and one derived from minutes 10, 12 and 14 $F(1,74)$

$= 0.93$, $p=.34$. This suggests that an acclimatisation period of longer than 8 minutes is not worthwhile.

7.3.2.2.5 Differential group acclimatisation

A subsidiary aim of the experiment was to evaluate whether there was any differential acclimatisation of systolic blood pressure in the experimental groups. The non-significant TIME x GROUP interaction suggests not, but this interaction test is an overall test not particularly sensitive to differences in the shape of an exponential curve, so it seems justified to explore this question further. Figure 7.5 shows the systolic blood pressure changes for participants in different experimental conditions.

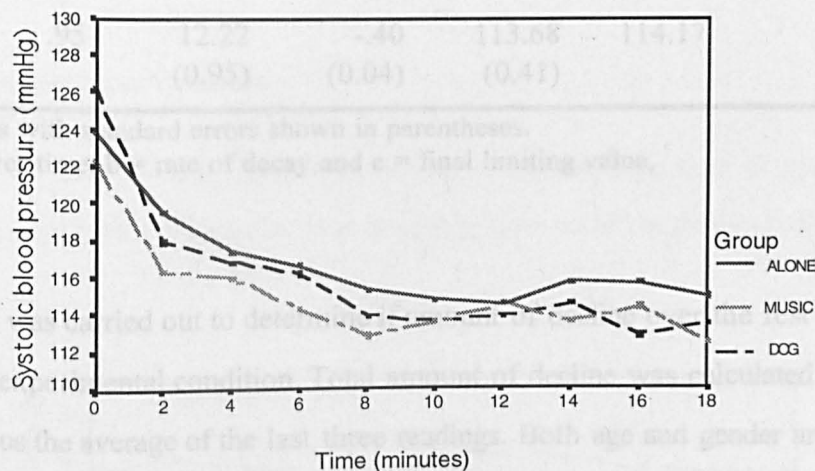


Figure 7.5 Differential changes in systolic blood pressure over the rest period for the three groups.

A visual inspection suggests that the groups might have a differential drop in baseline activity levels. When curve fitting procedures were applied, fits for each group's mean data were excellent. The value 'a' in the equation reflects the total theoretical drop from the value at 0 minutes to the limiting value. This is higher for the dog group reflecting their greater drop over the rest period. The rate of acclimatisation, value 'b' in the equation, is lowest for the control group, then the dog group, then the music group. A

larger magnitude decay value reflects a quicker decay and this is highlighted by the shorter time length for participants in the music condition to complete 95% of their acclimatisation. An eight minute acclimatisation period should result in levels within 0.50 mmHg of the limiting value for dog and music groups, for the control group, eight minute values are just above 0.50 mmHg at 0.60 mmHg.

Table 7.6 Exponential curve fitting for group systolic blood pressure data.

Dataset	r^2_{adj}	a	b	c	8 minute value	95% decay time
Alone	.97	8.95 (0.53)	-.34 (0.05)	114.96 (0.26)	115.56	8:49
Music	.91	8.67 (0.90)	-.46 (0.11)	113.51 (0.37)	113.74	6:31
Dog	.95	12.22 (0.95)	-.40 (0.04)	113.68 (0.41)	114.17	7:49

Note. Values with standard errors shown in parentheses.

a = decay over time, b = rate of decay and c = final limiting value,

An analysis was carried out to determine if amount of decline over the rest period was affected by experimental condition. Total amount of decline was calculated as the first reading minus the average of the last three readings. Both age and gender are known to affect resting values of systolic blood pressure, so these factors were also entered into an AGE x SEX x CONDITION analysis. The analysis showed that both gender $F(1,57) = 4.17, p=.05$ and experimental condition $F(2,57) = 4.09, p=.02$ affected the amount of decrease, with males and participants in the dog present group demonstrating a larger decrease in systolic blood pressure over the rest period.

The dog present group had a slightly higher entering systolic blood pressure, and as initial systolic blood pressure was shown to correlate significantly with amount of decline in the rest period ($r=-.60, n=75, p<.01$), this was added into a second analysis as a covariate. Entering systolic blood pressure was a significant predictor of amount of

relaxation $F(1,56) = 35.32, p < .01$. However, even with this covariate taken into account, there were still marginally non-significant differences between the conditions $F(2,56) = 3.17, p = .06$ with the dog group having a greater decrease in systolic blood pressure over the rest period than the other two groups.

However, it is well known that the first blood pressure reading in an experimental situation is inherently unreliable as it reflects adjustment to the measurement procedure. If the difference between the last three measurements and the second baseline measurement two minutes into the rest period are taken, there are no significant differences between the groups. Therefore, it would seem that the differences between the groups are caused by differing first readings as opposed to genuine differences between the groups in their decline over the rest period.

7.3.2.3 Diastolic blood pressure

The profile for diastolic blood pressure is very different from that of systolic blood pressure, average levels are similar over the entire time period as shown in Figure 7.6.

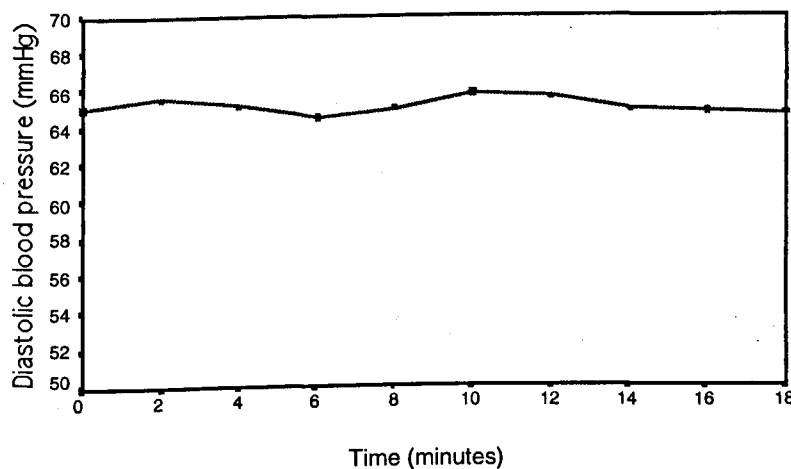


Figure 7.6 Mean levels of diastolic blood pressure over the rest period

As expected there was no difference by group in overall levels $F(2,72) = 0.38, p=.69$. The main effect of time was also non-significant, $F(9,648) = 0.73, p=.68$, this suggests that mean diastolic blood pressure levels did not vary significantly over the analysis period. The interaction between time and group $F(18, 648) = 0.59, p=.91$, is non-significant, showing that the variation over the rest period did not differ by experimental group of participant.

As there was no change over time, curve fitting procedures were not expected to produce valid answers. Adjusted r^2 values were negative for linear, quadratic and exponential trends demonstrating that these curves do not adequately model the data. The data would seem to best be represented by a constant value.

Fluctuations between the two minute readings are an average of 3.79 mmHg. This is higher than levels of 2-3 mmHg reported by Reeves (1995) for minute to minute fluctuations. However, it does not seem that allowing more time would lead to more stable levels. As shown in Figure 7.7, there is no pattern to the change in stability and no discernible trends to becoming more or less stable.

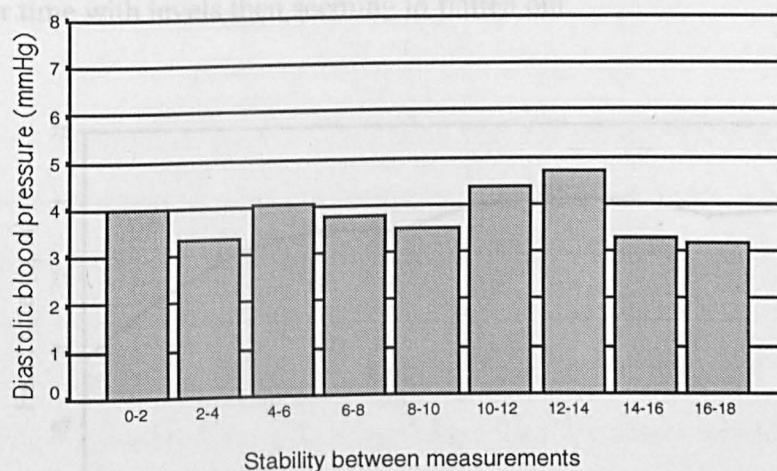


Figure 7.7 Stability of diastolic blood pressure over the rest period

This pattern is mirrored in the temporal stability indices which show no obvious

trends, as shown in Table 7.7. However, these values are all substantially lower than those reported by Jennings *et al.* (1992) of 3.2 to 4.3 for a standard baseline and 3.4 to 3.5 for the vanilla baseline. Baseline estimates based on averages of successive three measurements did not differ significantly across the rest period for any comparison.

Table 7.7 Temporal stability of successive diastolic blood pressure baselines

Baseline derived from measurements in these minutes of the rest period	Temporal Stability
0,2,4	2.27
2,4,6	2.21
4,6,8	2.24
6,8,10	2.09
8,10,12	2.18
10,12,14	2.30
12,14,16	2.22
14,16,18	2.01

Temporal Stability = within baseline standard deviation.

7.3.2.4 Heart rate

Heart rate trends over time are shown in Figure 7.8. As can be seen, there is a gentle increase over time with levels then seeming to flatten out.

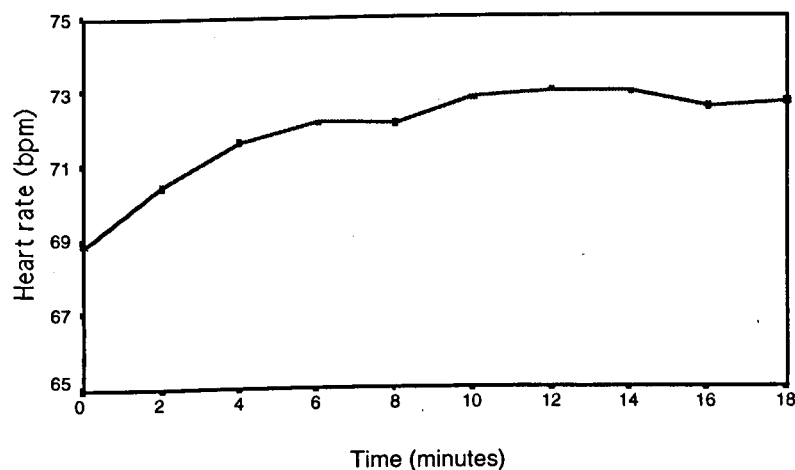


Figure 7.8 Mean levels of heart rate over the acclimatisation period

This profile is the reverse of the systolic blood pressure changes which showed a decrease to more stable levels as time went on.

7.3.2.4.1 ANOVA

As expected there was no difference by group in overall levels $F(2,72) = 0.30, p=.74$. Time as expected was a significant factor, $F(9,648) = 11.94, p<.01$, demonstrating that heart rate varied significantly over the analysis period. The interaction between time and group $F(18, 648) = 0.95, p=.51$, showing that the variation over the rest period did not differ by experimental group of participant.

7.3.2.4.2 Curve fitting

Curve fitting procedures were again used to model the data, results are shown in Table 7.8. The functional form test for both linear and quadratic curves was significant, whereas the test of the exponential model was non-significant. Therefore although the amount of variance explained by the quadratic and exponential curves is similar, the exponential curve is a better representation of the data. The 'a' value in the model is negative indicating an increase over time in levels, however the negative 'b' value indicates that levels are flattening out over time.

Using the previous formula, it can be estimated, that 95% of the decay will occur in the first 10:30 of the rest period. This is a longer time than the 8 minutes which is required for the 95% decay of systolic blood pressure data. However, at 8 minutes, the estimated heart rate levels are 72.43 bpm, only 0.41 bpm lower than the theoretical limiting value. Therefore although in relative terms longer is needed for heart rate acclimatisation, in absolute terms, allowing longer than 8 minutes would seem of little value.

Table 7.8 Curve fitting for heart rate rest period data.

Curve	Model	r^2_{adj}	a	b	c
Linear	$y = at + b$	.62	0.18 (0.04)	70.31 (0.48)	-
Quadratic	$y = at^2 + bt + c$	.95	-0.23 (<0.01)	0.60 (0.06)	69.18 (0.24)
Exponential	$y = ae^{(bt)} + c$	.97	-4.05 (0.24)	-0.29 (0.04)	72.84 (0.13)

Note. Values with standard errors shown in parentheses. All components make significant contributions to their respective models.

a, b, and c have different physical interpretations across models,
t = time in minutes, y = heart rate bpm, e = exponential constant

The exponential trends were explored in the male and female datasets, see Table 7.9. Similar results were found to the systolic blood pressure data, in that females show quicker acclimatisation, however there is little to separate the two regression equations.

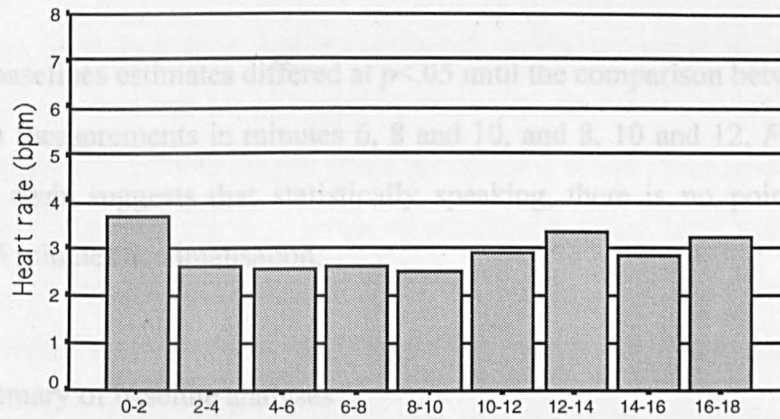
Table 7.9 Exponential curve fitting for male and female heart rate data.

Dataset	r^2_{adj}	a	b	c	8 minute value	95% decay time
Males	.82	-4.00	-.28	71.49	71.07	10:37
Females	.89	-4.09	-.29	73.91	73.50	10:20

Note. a = decay over time, b = rate of decay and c = final limiting value,
t = time in minutes, y = systolic blood pressure mmHg

7.3.2.4.3 Stability

The magnitude of change between successive readings for heart rate is shown in Figure 7.9. It seems that after an increase in stability, heart rate then becomes more unstable perhaps in anticipation of the stressor or due to boredom.



Stability between measurements

Figure 7.9 Stability of heart rate over the rest period.

Table 7.10 Temporal stability of successive heart rate baselines

Baseline derived from measurements in these minutes of the rest period	Temporal Stability (minutes:seconds)
0,2,4	2.15
2,4,6	1.65
4,6,8	1.58
6,8,10	1.55
8,10,12	1.60
10,12,14	1.88
12,14,16	1.98
14,16,18	1.80

Temporal Stability = within baseline standard deviation.

The temporal stability values reflect the measure-to-measure stability trends in that baselines seem at their most stable in the middle of the rest period in minutes 6, 8 and 10, see Table 7.10. These temporal stability values are lower than those published by Jennings *et al.* (1992) of 1.8 - 2.5 for a standard 10 minute baseline and 2.3 to 3.1 for the 10 minute vanilla baseline. Therefore stability of all potential baselines from the current dataset is better than reported in Jennings *et al.*'s study. However the increased instability towards the end of the rest period suggest that baseline measurements might be more usefully taken after 6 minutes acclimatisation.

7.3.2.4.4 Successive baseline estimates

Successive baselines estimates differed at $p < .05$ until the comparison between baselines derived from measurements in minutes 6, 8 and 10, and 8, 10 and 12, $F(1,74) = 2.67$, $p = .10$. This again suggests that statistically speaking, there is no point in allowing longer than 6 minutes acclimatisation.

7.3.2.5 Summary of baseline analyses

Table 7.11, summarises the conclusions of the various analyses as to how long an acclimatisation period should be allowed prior to baseline measurements.

Table 7.11 Summary of acclimatisation period analyses

Analysis criteria	Recommended acclimatisation period length (minutes: seconds)		
	Systolic blood pressure	Diastolic blood pressure	Heart rate
no meaningful decay remaining (<.5 mmHg or bpm estimated decay left)	7:39 +	no trends over time	7:20 +
no meaningful decay remaining (95% estimated decay occurred)	7:40 +	no trends over time	10:30 +
highest temporal stability (lowest within baseline SD)	12:00	14:00	6:00
point of no statistical difference in baseline estimates ($p < .05$)	8:00 +	no statistical difference between any baselines	6:00 +

+ = baselines after from longer acclimatisation periods exceed / also meet criteria.

For systolic measurements, guidelines converge around an 8 minute acclimatisation period. After this time no meaningful decay occurs in either absolute or relative terms and the statistical significance of the baseline measures does not change. Stability improves with a longer measurement time, but comparison with other studies suggests levels at 8 minutes are acceptable. Diastolic blood pressure essentially does not change

over time, therefore statements regarding meaningful decay are invalid. The diastolic levels seem to be at their most stable for the 6th minute period of the acclimatisation period, although this is not the culmination of a trend, therefore it is difficult to make any recommendations of how long to allow for diastolic blood pressure acclimatisation. For heart rate, estimated absolute levels of meaningful decay have occurred by 7:20 minutes, this is far shorter than the estimated level of meaningful relative decay. However it would seem that absolute rather than relative levels are more important. The point of most stable baselines begins at 6 minutes, after this time, levels become more unstable and the later baselines do not differ significantly from each other. Given the range of guidelines for heart rate, it would seem that 8 minutes seems an acceptable time length as well. This is congruent with the systolic blood pressure requirements, which if shorter would threaten reliable systolic baseline assessment, it exceeds the heart rate absolute meaningful decay point and the statistical significance point and is close to the point of best temporal stability.

7.3.3 Physiological main and reactivity effects

7.3.3.1 Analysis strategy

A four way MANOVA, with dependent variables of systolic blood pressure, diastolic blood pressure and heart rate, was used to examine main and reactivity effects. For each participant, a baseline estimate was estimated as the average of the three measurements at the end of the rest period, i.e. minutes 14, 16 and 18. This period was chosen, even though the previous baseline analyses suggest that a shorter acclimatisation time could have been allowed, as it is indicative of immediate values prior to the stressor. Additionally, it was not considered problematic to use a longer acclimatisation period, as there was no statistical difference between baselines for any measure estimated after 8 minutes and those estimated after 14 minutes acclimatisation. A task level was estimated as the average of the three measurements during the math task.

The between-subjects factors were GROUP with three levels (control, music, dog); AGE (young, 18-21 years; old 22-41 years); SEX (male, female); and there was a within-subjects factor of PHASE with two levels (baseline level, task level). Age and sex were included as factors in the analysis as they influenced baseline levels in experiment 1.

A full summary table for the MANOVA is shown in Appendix K, the analyses of interest are described below. Main effects of SEX, and AGE were expected on the basis of epidemiological data, with males and older participants showing greater blood pressure levels but lower heart rate levels than female or younger participants. The second analysis examined the main effect of GROUP to assess whether there were any differences in both baseline and task levels between the control, music and dog groups. No explicit hypotheses were generated for this effect. Third, the main effect of PHASE was examined, this would show the significance of any differences between the participants baseline and task levels i.e. their reactivity, and would indicate the effectiveness of the stress tasks in affecting cardiovascular variables. Reactivity was also examined with regard to factors of SEX and AGE, as in baseline data, males and older participants were expected to produce greater blood pressure reactivity, although in the previous experiment, no significant differences had been found. Fourth, the interaction between PHASE and GROUP was examined, this would show whether there were differences in reactivity between the groups. It was hypothesised that the dog and music groups would have lower reactivity than the control group.

7.3.3.2 Main effects of sex and age

There was a main effects of participant's sex on cardiovascular levels, Wilks's $\Lambda = 0.58$, $F(3,61) = 14.77$, $p < .01$. The pattern was similar to the previous study and epidemiological data, with males having higher blood pressures and females having higher heart rates. At the univariate level, however the sex differences were significant only for systolic blood pressure, as shown in Figure 7.10.

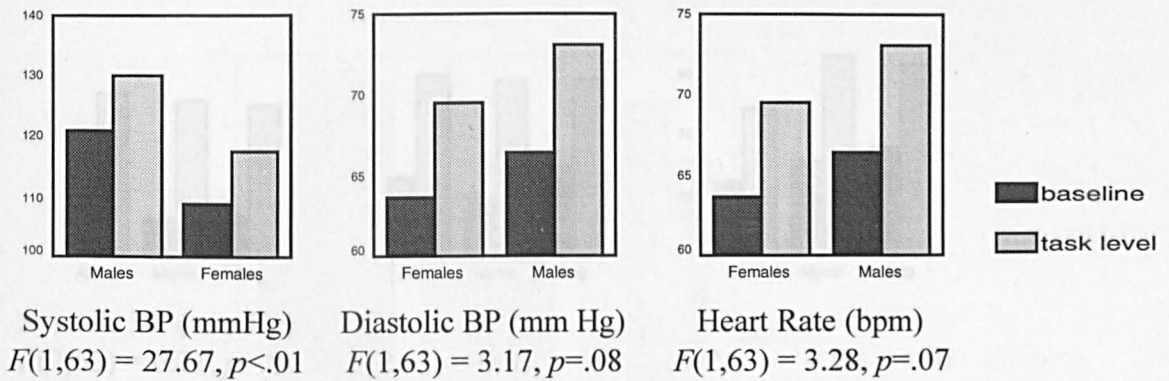


Figure 7.10 The effect of participant's sex on cardiovascular variables.

In this sample, the difference between older (22-44 years) and younger (18-21 years) participants' cardiovascular levels was non-significant, Wilks's $\Lambda = 0.92$, $F(3,61) = 1.78$, $p = .16$, see Figure 7.11.

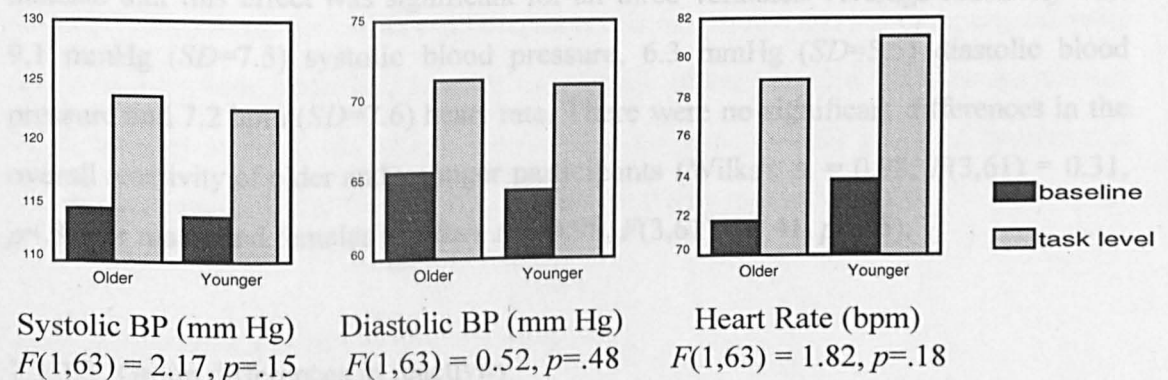


Figure 7.11 The main effect of age on cardiovascular variables.

7.3.3.3 Main effect of condition

This analysis investigates whether there was a main effect of the group, i.e. whether levels during baseline and task parts of the experiment differ between the groups. The baseline and task levels for each group are shown in Figure 7.12. There were no observable trends to this data, and no significant differences, Wilks's $\Lambda = 0.96$, $F(6,122) = 0.47, p = .83$.

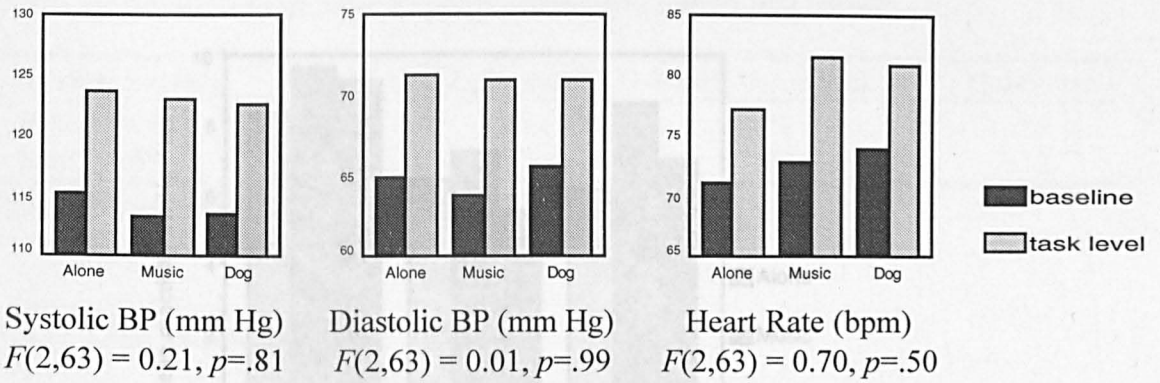


Figure 7.12 Baseline and task levels for each group and each physiological parameter.

7.3.3.4 The effect of the task (reactivity)

As expected, the math task was effective in significantly increasing cardiovascular measures, Wilks's $\Lambda = 0.35$, $F(3,61) = 37.69$, $p<.01$. Subsequent univariate tests indicate that this effect was significant for all three variables. Average reactivity was 9.1 mmHg ($SD=7.5$) systolic blood pressure, 6.3 mmHg ($SD=5.5$) diastolic blood pressure and 7.2 bpm ($SD=7.6$) heart rate. There were no significant differences in the overall reactivity of older and younger participants (Wilks's $\Lambda = 0.98$, $F(3,61) = 0.31$, $p=.81$) or males and females (Wilks's $\Lambda = 0.98$, $F(3,61) = 0.41$, $p=.75$).

7.3.3.5 Group differences in reactivity

The reactivity for each group, control, music and dog, is shown in Figure 7.13. There was no significant difference in the reactivity between the groups, Wilks's $\Lambda = 0.97$, $F(6,122) = 0.30$, $p=.94$. Thus showing that neither the dog nor music conditions resulted in lower reactivity to the math task than the control condition.

Table 7.12 Correlations between cardiovascular reactivity and anxiety

Anxiety measure	Systolic blood pressure	Diastolic blood pressure	Heart rate
State, $n=6$	.09	.01	.16
Trait, $n=6$	.05	-.01	.12

Note. No correlations are significant at the .05 level.

7.3.5 Task

The main task was to perform a mental arithmetic task while the mean score close to the

Systolic BP (mm Hg) $F(2,63) = 0.17, p=.84$
Diastolic BP (mm Hg) $F(2,63) = 0.32, p=.73$
Heart Rate (bpm) $F(2,63) = 0.33, p=.72$

Figure 7.13 Reactivity for each cardiovascular variable by group

There were no other significant effects or interactions within the MANOVA. In summary, significant differences in baseline levels for the age and sex comparisons were found only between males and females on systolic blood pressure. Neither age nor sex of participant affected reactivity. There were no experimental group differences in either combined baseline and task levels or in reactivity to either task.

7.3.4 Subjective anxiety

State and trait anxiety scores were computed according to guidelines in the test manual (Spielberger, 1983). As shown in Table 7.1, the trait anxiety scores of the participants did not differ between the groups. On state anxiety, there was missing data for five participants, 0:3:2 in the control, music and dog conditions respectively. State scores did not differ between the groups $F(2,67) = 0.75, p=.48$ suggesting that there was no effect of the conditions on state anxiety levels. Neither trait nor state anxiety scores related to cardiovascular reactivity to the task, see Table 7.12.

importance of the experiment in the participants' estimation, make the setting appear more relaxing, more pleasant, less formal and more humorous. On the basis of studies by Friedman and Lockwood (1991) and Rossbach (1992) it was hypothesised that the addition of a dog would make the experimenter appear less intimidating. Although

Table 7.12 Correlations between cardiovascular reactivity and anxiety.

Anxiety measure	Systolic blood pressure	Diastolic blood pressure	Heart rate
State, n=70	.09	.01	.16
Trait, n=69	.05	-.01	.12

Note. No correlation reached significance (all $p>.05$).

7.3.5 Task achievement

The math task performed similarly to the pilot, with the mean score close to the intended 60% correct level of 14/24. The mean score was 14.7 ($SD = 4.6$). Scores on the task were examined to determine whether the dog or music conditions provided a distraction to the participants and might have lowered their stress in this manner. There were no significant differences between the groups, see Figure 7.14.

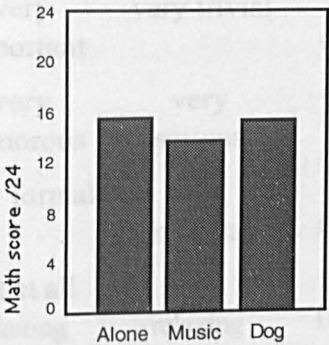


Figure 7.14 Mean math scores by group.

7.3.6 Subjective evaluations

An experimental evaluation questionnaire was designed to assess various aspects of the situation which might affect reactivity or relaxation, (details in section 7.2.4.3). It was hypothesised that the addition of a dog into the experimental situation might reduce the importance of the experiment in the participants estimation, make the setting appear more relaxing, more pleasant, less formal and more humorous. On the basis of studies by Friedmann and Lockwood (1991) and Rossbach (1992) it was hypothesised that the addition of a dog would make the experimenter appear less intimidating. Although

performance scores did not indicate any deficit in performance between the groups, the participants' subjective appraisal of how easy it was to concentrate in each condition was sought, as it was hypothesised that both the music and the dog might cause a distraction to the participant.

The mean rating for each experimental condition is given in Table 7.13. It can be seen that the three conditions did not differ on any measure. Using these brief measures, it does not seem that introduction of music or a dog into an experimental situation affects participant ratings of the experimenter or the experimental setting.

Table 7.13 Participants' evaluations of the experimental conditions.

Assessment of:	Scale anchor points		Condition			Analysis
	1=	6=	Control	Music	Dog	
experiment	very important	very trivial	3.0 (0.9)	2.7 (1.0)	2.6 (1.0)	$F(2,70) = 1.00$, $p=.37$
experimental setting	very humorous	very serious	5.0 (0)	5.0 (1)	5.0 (2)	$H(2, N=73) = 1.48$, $p=.48$
experimental setting	very formal	very informal	2.4 (1.1)	3.2 (1.5)	2.8 (1.4)	$F(2,70) = 2.01$, $p=.14$
experimental setting	not at all relaxing	very relaxing	4.2 (1.3)	4.4 (1.2)	4.2 (1.4)	$F(2,70) = 0.22$, $p=.81$
experimental setting	very unpleasant	very pleasant	4.2 (0.9)	4.3 (0.7)	4.1 (1.1)	$F(2,70) = 0.26$, 0.78
experimenter	very intimidating	very reassuring	4.8 (0.8)	4.6 (0.8)	4.7 (0.9)	$F(2,70) = 0.36$ $p=.70$
task	easy to concentrate	not easy to concentrate	3.4 (1.5)	2.7 (1.5)	2.9 (1.6)	$F(2,70) = 1.33$ $p=.27$

Note. Group means with standard deviations in parentheses or medians with interquartile range are shown.

Missing data on all measures for one participant in the music condition and one participant in the dog condition.

7.4 Discussion

The main aim of this experiment was to include a longer baseline rest period so that participants would be able to reach stable levels of cardiovascular activity prior to the stress task. It was hypothesised that unstable baseline levels from a shorter period would make the estimate of reactivity less reliable and might attenuate any change. The data confirm the necessity of allowing an acclimatisation period prior to measurement of baseline levels, as for both systolic blood pressure and heart rate there are significant changes over the rest period. This recognition is hardly new to mainstream cardiovascular research, however, a number of companion animal studies have omitted any acclimatisation period or used periods which seem too short to allow stabilisation of cardiovascular levels. The decision as to how long the acclimatisation period needs to be however, is more complex and neither the mainstream nor companion animal literature seems to have settled on a time.

A number of strategies were used to enable examination of how long to allow for acclimatisation. Criteria of meaningful relative and absolute remaining acclimatisation were generated based on an exponential model of change, which fits the heart rate and systolic blood pressure data very well. This allows a confident estimate to be made of the theoretical total acclimatisation, i.e. change from entering levels to the theoretical eventual limit were measurements to continue (assuming that boredom or other effects do not intervene).

From this estimate, meaningful acclimatisation point was defined as when either 95% of the acclimatisation had occurred or levels were within .5 of the final limiting value. Using these guide lines it can be estimated that for systolic blood pressure, absolute and relative meaningful acclimatisation occurs by 8 minutes and for heart rate absolute meaningful acclimatisation occurs by 8 minutes, with relative meaningful acclimatisation taking slightly longer at 10.5 minutes.

No trends over time were found for diastolic data, this replicates the findings of Goodman *et al.* (1996) who also found no diastolic trends in a similar young sample. In contrast to the majority of previous reports which note that heart rate declines over the rest period, in this study heart rate showed a small increase over time.⁷ It is not clear why this dataset should show this pattern.

Examination of stability provides another method of determining how long to measure for. Within-baseline standard deviations were calculated, as performed by Jennings *et al.* (1992). There appear to be no set guidelines as to acceptable levels of temporal stability. However, the levels obtained in the current dataset are much lower than within-baseline standard deviations found by Jennings *et al.* Part of this discrepancy may reflect the fact that Jennings *et al.* appear to have averaged measurements taken after three minutes acclimatisation at 90 second intervals for up to 10 minutes. Therefore their estimates are based on more measurements and may include measurements before the participant acclimatises. Generalizability theory would suggest that in laboratory conditions, only two blood pressure measurements are required to reach reliability levels over .90 (Llabre *et al.*, 1988). The average of three measurements in the current study is therefore perhaps unnecessary, however this is in line with expert guidelines (Shapiro *et al.*, 1996). There does not seem to be any advantage to deriving baseline estimates from many more measurements, as this lengthens the rest period duration.

Successive systolic blood pressure measurements become more and more stable over the entire period and on this basis measurements should continue for more than 20 minutes. However, heart rate becomes more stable over the first 6 minutes of the rest period but after that it starts to become less stable. This suggests that there may be an optimum point at which to take baseline measurements after which participants

⁷ Analysis of data in the other three studies in the series as reported in **Appendix J** suggests that this is not a spurious finding as it was also seen in the young sample of the third experiment and in the younger half of the sample in the fourth study. A decrease in heart rate over time was seen in older participants only and this suggests that this trend may be bound up with age effects.

become bored and fidgety. Continued monitoring may lead to a more accurate estimate of basal systolic blood pressure but it may produce a less accurate estimate of basal heart rate. Statistical comparison of successive baselines indicates that for heart rate after 6 minutes acclimatisation and for systolic blood pressure after 8 minutes of acclimatisation, the baselines do not differ significantly.

Taking into account all the various tests and considerations, from the data in the current study, it is recommended that 8 minutes are allowed for acclimatisation prior to collection of baseline data. This is similar to the recommendations of Goodman *et al.* (1996) of an acclimatisation period of at least 5 cuff inflations over 6.5 minutes and Jennings who suggest a 10 minute total rest period, but much shorter than the recommendations of Shapiro (1996) of 20 minutes for blood pressure and Hastrup (1986) and Dobkin *et al.* (1994) who both suggest at least 15 minutes adaptation for heart rate. The discrepancy in duration may be due to the different nature of participants used or considered by these researchers. Goodman *et al.* used young participants (mean age 19.5 years), Dobkin *et al.* used slightly older participants (mean age 24 years), Jennings *et al.* used participants (aged 18-50 years) whereas the guidelines of Shapiro and Hastrup are based on surveys of literature with many ages of participants. Further analyses of different age samples as detailed in Appendix J suggest that acclimatisation periods should be lengthened with older participants.

Dobkin *et al.* proposed that a post-stressor baseline would be superior to one taken either in advance of the stressor or on a separate day. However in this experiment, the post-stressor baseline was significantly higher than the baseline taken at the end of 8 minutes. This is probably due to the fact that not enough time was left after the end of the task to recover prior to baseline readings being taken. Therefore the current study cannot be said to have adequately tested the usefulness of a post-stressor baseline.

In addition to examining the general trends in acclimatisation over the rest period, a second aim of the experiment was to see whether the presence of a dog or music might

affect the rate of acclimatisation. There were no differences between the groups on changes over the rest period in diastolic blood pressure or heart rate. An analysis of the decline over the rest period found that the dog group had significantly greater decrease in systolic blood pressure over the entire rest period. However, at the end of the rest period, the baseline levels of systolic blood pressure, diastolic blood pressure and heart rate were comparable between the groups. This suggests that the differential decrease is more attributable to the increased entering levels which may reflect the additional uncertainty caused by the presence of a dog, but which certainly do not indicate that the dog has a calming effect. There is no real difference in the rate of acclimatisation of the dog group from the other two groups. However, there is some suggestion that use of music enables participants to acclimatise more quickly

The experiment failed to find significant differences in reactivity between a group with a dog present and other experimental conditions. This again emphasises that if this effect does exist, it is very unreliable and not easy to replicate. The absence of an effect does not seem to be due to an unstable or inflated baseline, as the baseline was long enough to permit participants to reach stable levels of cardiovascular activity which would be expected to be close to their basal level of activity. Additionally, asking participants to refrain from behaviour such as eating, consuming caffeine, alcohol, or nicotine or exercising improved the numbers of participants not reporting this behaviour. This should have reduced an additional source of variability in participants.

Effects of participant's biological sex on baseline levels showed strong trends in the expected direction for all measures with blood pressure being higher and heart rate being lower in males. There was no effect of age on baseline cardiovascular activity in this experiment. This could be as the sample was fairly homogenous with respect to age, with 68% of participants aged 18-25 years. As expected, the stressor was successful in producing significant increases in cardiovascular levels. The maths task used in this experiment had been previously piloted to ensure 60% success rate. The results were close to this, with a mean score of 14.7 (61.3%). Therefore the study appears well

designed and to have been reasonably likely to detect expected effects.

The current study made an initial attempt to evaluate subjective appraisal of the experimental situation. Participants were asked to rate formality of the experiment, the experimenter and their ability to concentrate in the tasks. These subjective ratings did not vary between conditions. It is difficult to evaluate the direction of these scores, as the differences between them are non-significant. There were no differences between the conditions in the participants rating of how reassuring the experimenter's behaviour was. This suggests that the participant's impressions of the experimenter were not modified due to there being a dog present as might be suggested by some which suggests that people pictured with animals are rated more favourably than those without animals (Lockwood, 1983; Rossbach & Wilson, 1992). However as only one question was used to examine perceptions of the experimenter, this could be improved in the next experiment by asking a number of questions which might reveal specific differences. Formality was assessed in this setting by five questions, although none of these questions showed significant univariate trends towards significance.

After the first experiment, it was thought that the inability to gain significant results of a dogs' presence might be due to methodological weaknesses. However it now seems that methodological reasons do not underlie the inability of previous studies to find effects. Nonetheless, before abandoning this experimental design, there is one further consideration. In both of the previous experiments, attempts were made to control and limit the natural interaction which might occur between participant and experimenter. This was part of good experimental practice and an effort to prevent unequal conversation which might occur in the presence of the novel stimuli of a dog or music. However it may be that unwittingly this also removed the stress moderation effect. As this appears to be the only remaining impediment prior to accepting that a stress moderation effect of an unfamiliar animal does not exist in this type of study, this will be the focus of the next study.

Chapter Eight

Experiment Three - Examination of the role of social catalysis

8.1 Introduction

The third experiment in this series was designed to examine whether stress moderation from the presence of a companion animal is due to the ability of the animal to provoke social interaction between the experimenter and the participant.

8.1.1 Social catalysis

The phenomenon of animals increasing the levels of social interaction between strangers is well known. It has variously been termed '*social lubrication*' (Mugford & M'Comisky, 1975), '*social facilitation*' (Messent, 1983; Messent, 1985), '*bonding catalysis*' (Corson & Corson, 1981) and '*social catalysis*' (McNicholas & Collis, unpublished; McNicholas *et al.*, 1996).

Social catalysis has been demonstrated in a number of settings and with various populations. Messent (1983) in a set of studies found that the presence of a dog significantly increased the number of conversations that a person walking was engaged in and that the effect of a dog was more potent than that of a child in a pram. Messent found that neither age nor sex of the conversants, city of study nor pedigree status of the dog affected the duration of conversations. McNicholas and Collis (unpublished) found that scruffiness of the dog did not moderate the social catalysis effect and although scruffiness of the 'owner' did reduce the number of interactions, even a scruffy person with a dog was engaged in many more social interactions than a scruffy person without a dog or a smart person without a dog. Hunt, Hart and Gomulkiewicz

(1992) found that the effect extended to other animals and found catalysis effects for people sitting with a rabbit or turtle in a park. A social catalysis effect has also been noted for special populations with dogs, such as people in wheelchairs (Eddy *et al.*, 1988; Hart *et al.*, 1987), visually impaired people and hearing impaired people (Hart *et al.*, 1996).

If the presence of a dog in a laboratory setting also acts as a social catalyst and results in longer or more frequent social interaction between the experimenter and the participant, it is likely that these interactions will be positive in nature. Both experimenter and participant have an investment in a smooth social interaction. The participant may be seeking reassurance regarding the forthcoming procedure and the experimenter does not want the participant to withdraw. Uchino and Garvey (1997) found that supportive comments by the experimenter, even though not resulting in any explicit actions, reduced blood pressure reactivity to a speech task. Other studies, as reviewed in table 3.2, have found that comments and actions by confederates or friends which are designed to be supportive, reduce the reactivity of a participant to stress tasks in the laboratory. Tardy (1994) has also demonstrated experimentally that supportive comments are perceived as stress reducing by participants engaged in problem solving tasks. Therefore, it is possible that increased social interaction provoked by the presence of a dog may lead to lower reactivity.

Variability in the presentation of information and instructions is recognised as a factor which may affect the outcome of the experiment. The use of taped or scripted instructions is recommended as a way of standardising the presentation of information to a participant (Eliot, 1988). The previous two experiments in this series used scripts for presentation of instructions. This was a measure included as part of good experimental practice. However, in the first study it was found that participants tended to enter the room talking and that, in order not to be rude, the experimenter needed to respond to these initial greeting phase interactions prior to the commencement of the 'script'. In this first study it was possible that the presence of

the dog might have increased interaction, however this was not systematically recorded. Although some participants did comment on the presence of the dog, the experimenter curtailed these openings with a standard comment so they did not evolve into further conversations. It is uncertain what effect these 'curtailed' comments may have had upon the participants in terms of presenting the experimenter in an unfriendly light or as just acting strangely towards people who were giving up their time to help her out. To resolve this ambiguous situation, in the second experiment, all participants were greeted in a room without the dog present. This meant that if a conversation occurred prior to the commencement of the script, then this would not be attributable to or affected by the presence of the dog.

In neither of the experiments was the presence of the dog linked to lower reactivity. Methodological refinements were included in both studies, and it does not seem that either lack of power or other design faults can be implicated for the lack of effect. As the social catalysis potential of the dog may well have been removed in both experiments, it is unclear whether the lack of effect hinged on this control. In order to fully test this possibility it was necessary to compare reactivity in a dog present condition where any social catalysis effects could run their course, with another condition, where the social catalysis potential was controlled. If reactivity was moderated in the dog condition where social catalysis might occur, and not in the dog condition where social catalysis had been inhibited, then this would unambiguously attribute the 'dog effect' to a social catalysis effect.

8.1.2 Subjective explanations

If it is assumed that a stress moderation effect of a companion animal exists, it is important to determine the mechanisms which produce this effect, as some effects might be artefacts of the experimental situation and not expected to generalise to the relationship between pet owners and their pets in daily life. It is possible that more than one type of explanation is working in one setting. Also as main effects have only

been seen with unfamiliar dogs in laboratory settings and reactivity effects only seen with the person's own pet in their own home, it is possible that different effects work in formal and informal situations and with familiar and unfamiliar animals.

The previous experiment allowed examination of whether threat levels were affected by the presence of a dog and brief assessment of perception of the experimenter and ability to concentrate. These were found not to differ by experimental condition, however as the assessment was very brief, it was decided to extend this in the current study.

8.1.2.1 Threat

Reduction in perceived threat of the situation was proposed as a mechanism which may result from the presence of a companion animal and which might account for the reduction in cardiovascular activity found by Friedmann *et al.* (1983b) in their study. Lockwood (1983) also found that inclusion of a dog in a pictured scene made it seem less formal. However in the previous study presence of the dog was found not to affect ratings of a number of items which might seem to reflect formality, therefore these items were included again to see if this unexpected 'non-effect' was seen again.

8.1.2.2 Perception of experimenter

Although the threat of a setting may be due to the physical environment, the nature of the experimenter may also contribute to this rating (Kamarck *et al.*, 1995). It has been proposed that people associated with animals are perceived as less threatening and more friendly (Messent, 1985). This suggestion has received experimental support in that character judgements of people pictured with animals are more positive (Friedmann & Lockwood, 1991; Lockwood, 1983; Rossbach & Wilson, 1992). The key characteristics they found to be rated more positively were happiness, being relaxed, and a composite factor including ratings of being gentle, friendly, and sympathetic. No previous experiment has examined perceptions of real people

encountered with or without real animals. Therefore these characteristics were measured in this experiment to see if the effects carried over to a scenario where the person actually meets a person with and without a dog.

8.1.2.3 Distraction

The presence of a companion animal may act as a focus for attention in an experimental setting. This suggestion was made by Locker (1985). Distraction has also explicitly been suggested as a mechanism in experiments on children in treatment settings (Hansen *et al.*, in press; Nagengast *et al.*, 1997). Boredom within an experimental setting, especially during a baseline period where it is hoped participants are able to relax and acclimatise to the experimental setting, can prevent cardiovascular levels reaching a baseline level (Jennings *et al.*, 1992). Previous researchers investigating the physiological effects of watching a companion animal have equated the observation of living animals with a hypnotic or meditative effect which has the ability to reduce blood pressure (Katcher *et al.*, 1983).

To assess whether the presence of the dog acts as a focus for attention in the experiment, both objective performance measures and subjective ratings can be examined. The subjective ratings aimed to assess both ability to concentrate on the task and also to use an open question to see whether participants spontaneously mention thinking about the dog during the rest period. If the dog was providing a focus for attention during the rest period, it might be expected that fewer participants would rate this period as being too long. Although objective performance has previously been examined to see if presence of a dog produces a distraction, the subjective aspects have not been explored.

8.1.2.4 Expectancy effects

It has long been recognised that participants taking part in an experiment are likely to want the experiment to be a success and to be a 'good subject' (Orne, 1962). They

may therefore deliberately act in accordance to what they perceive the experimenter's hypotheses. Orne has termed the cues, which may provide information to the participant of the aims of the experiment, demand characteristics of the experimental situation (1962). These cues include not only interaction between the participant and experimenter during the experiment but also information provided in recruitment of the participant, the demeanour of the experimenter, the setting of the laboratory and rumours or other information which the participant may have received regarding the aims of the experiment.

In some experiments, the true purpose of the experiment is kept from the participant, until debriefing. However, this is easier in some studies than in others. If an experiment involves a feature as conspicuous and unusual as a dog, it is likely that the participant will make certain guesses as to the theories of the experimenter. The potential stress reducing effects of companion animals are well publicised in the popular press and accepted by many members of the general public. Therefore an experimenter must take into account that a participant may be aware of the broad aims of the experiment and may try to act in a congruent manner.

Biofeedback suggests that people can affect their own physiology. Therefore if people expect to be relaxed and can affect their own physiology, this might cause increased relaxation prior to the task or perhaps reduced reactivity. To assess this possibility, participants were asked their perceptions of the purpose of the study. They were also asked whether they expected to be relaxed by the presence of the dog and whether their expectations were related to any stress moderation.

8.1.3 Summary of design

The design of the study allows explicit testing of the 'social catalysis' hypothesis that stress moderation occurs due to increased positive interaction between the experimenter and participant. Measures taken during the course of the study can

examine suggestions that: a) the presence of the dog reduces the perceived threat of the environment; b) the presence of the dog makes the participants perception of the experimenter more positive; c) the presence of the dog provides a focus for attention or distraction; d) the presence of the dog acts as a demand characteristic which cues participants to relax - it is hypothesised that existence of any of these effects may lead to reduced cardiovascular reactivity in the dog present conditions as opposed to the control conditions.

8.2 Method

8.2.1 Participants

The target number of participants for the experiment was determined by power considerations. For an 80% likelihood of detecting a large sized main effect, in a 2x2x2 ANOVA, using a two tailed test with an α of .05, a minimum of 14 participants per cell or 56 in total were required (Cohen, 1992).

The participants for the experiment were 80 university students, 32 males and 48 females. Participants were aged between 18 and 21 years, mean age 19 years ($SD=0.7$). The majority were recruited from an introductory psychology class and received course credit for their participation. Participants recruited externally received £2.50 expenses payment to compensate them for their time. None of the participants knew the experimenter prior to the study. Participants were pre-warned to refrain from eating or smoking for 2 hours, ingesting caffeine or undertaking exercise for 3 hours and ingesting alcohol for 12 hours prior to the experiment. Participants did not report any history of heart or circulatory conditions which might affect the validity of the measurements, or any health condition which might endanger them from frequently repeated blood pressure measurements. In addition, checks were made that

participants were not taking any medication which may affect the cardiovascular system.

The study used a baseline-task comparison embedded in a 2x2 between-subjects design with two main factors of DOG (present, absent) and TALK opportunity for interaction in greeting phase (open, closed). In this experiment, the crucial greeting phase of the experiment was treated in two distinct ways. In the *open condition*, reminiscent of experiment one, the participant was greeted in the experimental room, where the dog might be present. This would allow, if it naturally occurred, for the participant to comment upon the presence of the dog. The conversation which might ensue would not be prolonged deliberately, but would be taped for later and independent assessment of its content. In the *closed condition*, reminiscent of experiment two, the participant would be greeted in a separate room, so even if they were in the dog present condition, the dog would not be present at the greeting phase.

This led to four experimental conditions. One stress task was used. For each sex, participants were allocated randomly to the TALK condition, and allocated to DOG condition according to the availability of the dog.

8.2.2 Task

The task used in this study was the same as used in experiment two. This task was successful in the previous study of producing substantial cardiovascular increases 6-9 points in cardiovascular variables. Mean performance was approximately 60% success in both piloting and in experiment two which used a similar student sample.

8.2.3 Apparatus

As in previous experiments, an Apple Macintosh IIfx computer was used to present the mental arithmetic task and a Critikon Dinamap 8100 monitored the physiological dependent variables of systolic blood pressure, diastolic blood pressure and heart rate.

A Philips N2235 portable, battery powered, tape recorder was used to record the conversation in the experiment. Each experimental session was recorded onto a c90 tape which allows 45 minutes recording.

8.2.4 Measures

8.2.4.1 Demographic questionnaire

Prior to the measurement part of the experiment, participants completed a demographic questionnaire which asked about factors such as age, gender, weight and height for calculation of a body mass index (BMI), smoking status and their family history of blood pressure which might all be expected to affect cardiovascular activity. The questionnaire also asked about attitudes towards dogs which might be expected to affect responses of participants in the dog present conditions.

8.2.4.2 State-Trait anxiety inventory

The state-trait anxiety inventory (Spielberger, 1983) was used to measure anxiety levels.

8.2.4.3 Experimental assessment form

Building on the interesting results from experiment two, the experimental assessment form was extended. Participants were asked for their subjective views on a six point scale covering aspects of: a) pleasantness, formality, relaxing aspects and seriousness of experimental setting; b) manner of experimenter - professionalism, reassurance, friendliness, nervousness, talkativeness, approachability, enabling participant to relax and likeability; c) ability to focus on maths task and effort expended. Participants in the dog conditions were asked specifically about their reactions to the experimental dog and any expectancy of relaxing effects. A copy of this questionnaire can be seen in Appendix L.

8.2.4.4 Pre-experimental behaviour questionnaire

The pre-experimental behaviour questionnaire was the same as used in experiment two and asked for details on recent stress levels, caffeine, alcohol and food consumption and exercise and smoking habits within a time-frame likely to affect cardiovascular variables. A copy of the questionnaire can be seen in Appendix I.

8.2.5 Procedure

According to condition, participants were greeted in either the experimental room or in the ante-room. Participants in the open talk condition were greeted in the experimental room, and the introductory greeting was structured so that they might comment on the dog if present or discuss issues with the experimenter generally. After the initial greeting, participants were asked to take a seat in front of the computer. A deliberate pause was left, as the experimenter went to shut the door, between the participant being asked to sit down and the experimenter giving the instructions. Participants could fill this pause if they desired, by commenting on the dog or making other small talk. No explanation of the dog's presence was volunteered. However, if participants asked, they were told it's name and that it was very friendly. Participants were provided with information on the content of the experiment and informed consent was gained prior to the start of the experiment.

The participants in the closed talk condition were greeted in a room separate from the experimental room. This removed the possibility of the dog's presence to influence the interaction at the start of the experiment. An identical set of information was provided and informed consent gained. They were then brought into the experimental room where the dog might be present, and seated in front of the computer. In the previous experiment, starting the experiment in the ante-room was found to be successful in ensuring that participants did not comment on the dog.

Once participants were seated in the experimental room and informed consent had

been gained, the same procedure was followed for all participants. All participants filled out the demographic questionnaire and trait portion of the state-trait anxiety inventory. After this point, all participants were asked not to talk during the measurement procedure. The blood pressure monitor was then fitted to their non-dominant arm.

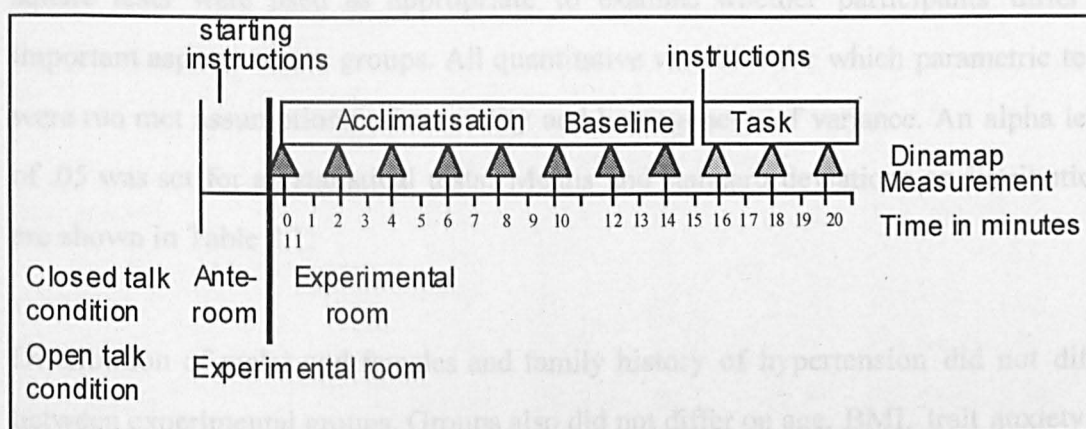


Figure 8.1 Plan of the procedure in experiment three.

A diagram of the procedure is given in Figure 8.1. The Dinamap took measurements at two minute intervals throughout the measurement period. The first measurement period was a fifteen minute rest period. A baseline level was estimated for all participants from the average of the final three measurements taken in minutes 10, 12 and 14 of the rest period. There then followed a maths task with measurements taken 0:30, 2:30 and 4:30 minutes into the task.

At the end of the maths task, the measurement phase was terminated and the pressure cuff was removed. Participants were asked to complete the state anxiety, experimental assessment and pre-experimental behaviour questionnaires. At the end of the experiment, the participants were debriefed and allowed to ask any questions or make comments regarding the procedure. Psychology undergraduates were additionally given a departmental assessment form to return independently. Participants being paid were paid at this point. Total testing time for each participant was about 50 minutes.

8.3 Results

8.3.1 Participant characteristics

For the purpose of these analyses, the four groups produced by the DOG and TALK factors were treated as four levels of a single factor. Analyses of variance and chi-square tests were used as appropriate to examine whether participants differ in important aspects across groups. All quantitative variables for which parametric tests were run met assumptions of normality and homogeneity of variance. An alpha level of .05 was set for all statistical tests. Means and standard deviations or distributions are shown in Table 8.1.

Distribution of males and females and family history of hypertension did not differ between experimental groups. Groups also did not differ on age, BMI, trait anxiety or reported recent stress levels. On attitude to dogs, the group in the closed interaction and dog absent condition reported a more negative attitude towards dogs than the other experimental groups: This was marginally non-significant. Although not ideal, this was considered not serious, as the more negative attitude was in a group not exposed to the dog. On both baseline diastolic blood pressure and heart rate, the group tested in the open interaction, dog absent condition had lower levels than other groups. This difference reached significance for diastolic blood pressure and was marginally non-significant for heart rate. Due to these concerns, baseline levels were further scrutinised in the subsequent analyses of physiological data as discussed in Section 8.3.2.2.

Table 8.1 Group variations in salient demographic and attitudinal variables.

Variable	Dog absent		Dog present		Analysis
	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20	
dichotomy ratio					
Sex. (male: female)	6:14	6:14	6:14	6:14	$\chi^2(3, N=80) = 1.0$, $\phi = .00$, $p = 1.0$
Regular smoker (yes:no)	3:17	5:15	5:15	1:19	$\chi^2(3, N=80) = 3.81$, $\phi = .28$, $p = .28$
means (standard deviations)					
Age (years)	19.2 (0.6)	19.4 (0.8)	19.2 (0.7)	19.2 (0.7)	$F(3,76) = 0.32$, $r^2 = .01$, $p = .81$
BMI ^a	21.1 (2.2)	22.1 (2.8)	22.4 (2.5)	21.8 (2.8)	$F(3,71) = 0.93$, $r^2 = .04$, $p = .43$
Trait anxiety	42.6 (9.7)	39.6 (8.4)	40.5 (7.0)	42.1 ^b (6.8)	$F(3,75) = 0.58$, $r^2 = .02$, $p = .63$
Prior stress (1= intense, 2= a lot, 3= tolerable, 4= very little, 5= none)	2.8 (0.7)	2.8 ^c (0.8)	3.0 (0.9)	3.0 (0.8)	$F(3,75) = 0.28$, $r^2 = .01$, $p = .84$
Attitude towards dogs (1= dislike dogs intensely, 7= like dogs intensely)	4.3 (1.9)	5.3 (1.5)	5.4 (1.1)	5.2 (1.3)	$F(3,76) = 2.52$, $r^2 = .09$, $p = .06$
Baseline systolic blood pressure (mmHg)	112.7 (8.0)	112.5 (7.4)	114.6 (7.1)	114.8 (6.9)	$F(3,76) = 0.56$, $r^2 = .02$, $p = .64$
Baseline diastolic blood pressure (mmHg)	61.4 (6.9)	59.1 ^d (6.4)	63.0 (5.2)	65.0 ^d (8.1)	$F(3,76) = 2.72$, $r^2 = .09$, $p = .05$
Baseline heart rate (bpm)	74.1 (10.5)	68.2 (8.7)	76.5 (9.2)	72.8 (11.3)	$F(3,76) = 2.45$, $r^2 = .09$, $p = .07$

Note. a = missing data on BMI for five participants, 3:0:0:2 for experimental groups respectively.

b = missing data trait anxiety score for one participant.

c = missing data on prior stress scale for one participant.

d = groups differ at $p < .05$.

Adherence to pre-experimental controls on previous smoking (93%), caffeine (94%), alcohol use (100%) and exercise (99%) prior to the experiment was fairly good and evenly spread between groups, see Table 8.2. The number of participants adhering to the eating restriction was lower (80%), although also evenly distributed between the

experimental groups.

Table 8.2 Adherence to pre-experimental controls

Restriction time frame	Able to adhere (yes : no)				Analysis
	Dog absent		Dog present		
	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20	
Eating < 2 hours	17:3	18:2	14:6	15:5	$\chi^2(3, N=80) = 3.13$, $\phi = .20, p = .37$
Caffeine < 3 hours	18:2	19:1	19:1	19:1	$\chi^2(3, N=80) = 0.64$, $\phi = .09, p = .89$
Smoking < 2 hours	17:3	20:0	17:3	20:0	$\chi^2(3, N=80) = 6.49$, $\phi = .28, p = .09$
Strenuous exercise < 3 hours	20:0	20:0	20:0	19:1	$\chi^2(3, N=80) = 3.04$, $\phi = .19, p = .39$
Alcohol < 12 hours	20:0	20:0	20:0	20:0	$\chi^2(3, N=80) = 1.0$, $\phi = .00, p = 1.0$

8.3.2 Physiological data

8.3.2.1 Analysis strategy

For each participant, a baseline estimate was taken as the average of the three measurements at the end of the rest period. A task level was estimated as the average of the three measurements during the math task.

The main analysis was a four-way multivariate analysis of variance (MANOVA) with three dependent variables of systolic BP, diastolic BP and heart rate. The between-subject factors were DOG (presence, absence) and TALK (open or closed opportunity to talk); SEX (male, female); there was a within-subject factor of PHASE with two levels (baseline level, task level). Biological sex was included as a factor as this has a significant effect on resting cardiovascular activity and reactivity (Matthews

& Stoney, 1988). Age was excluded as a factor in this analysis. The sample had an age range of only two years, and experiment two using a wider age range had found no age effects, therefore no age effects were expected.

A full summary table for the MANOVA is shown in Appendix M, the analyses of interest are described below. The results are presented in the order of consideration of the main effects of SEX, TALK and DOG which would demonstrate whether there were any differences in overall cardiovascular activity (baseline and task levels combined). Epidemiological data suggest that males would have higher blood pressure levels but lower heart rates than females, although experiment one and experiment two found significant effects on blood pressure only and systolic blood pressure only, respectively. Second, the main effect of PHASE which would show any differences between the participants' baseline and task levels i.e. their reactivity, and would indicate the effectiveness of the stress tasks in affecting cardiovascular variables. Third, the interaction between PHASE and the between-subjects factors of SEX, TALK and DOG would show whether any of the between-subjects factors influenced reactivity. If the presence of the dog itself provides a moderation of reactivity, then it would be expected that there would be an effect of DOG group with the dog present groups having lower reactivity than dog absent groups. If the stress moderation of the presence of a dog depends on the social interaction, which was limited in the closed talk condition, then an interaction between factors of TALK and DOG would be expected with the stress moderation from the presence of a dog being more potent in the free TALK condition. On the basis of the previous experiments, no differences were expected in the reactivity of male and female participants.

8.3.2.2 Main effects of sex and experimental group

In this sample there were effects of participant's sex on cardiovascular levels, Wilks's $\Lambda = 0.61$, $F(3,70) = 14.93$, $p < .01$. The pattern was similar to the previous experiments with males having higher blood pressures and females having higher heart

rates. At the univariate level, however the sex differences were significant only for systolic blood pressure, as shown in Figure 8.2.

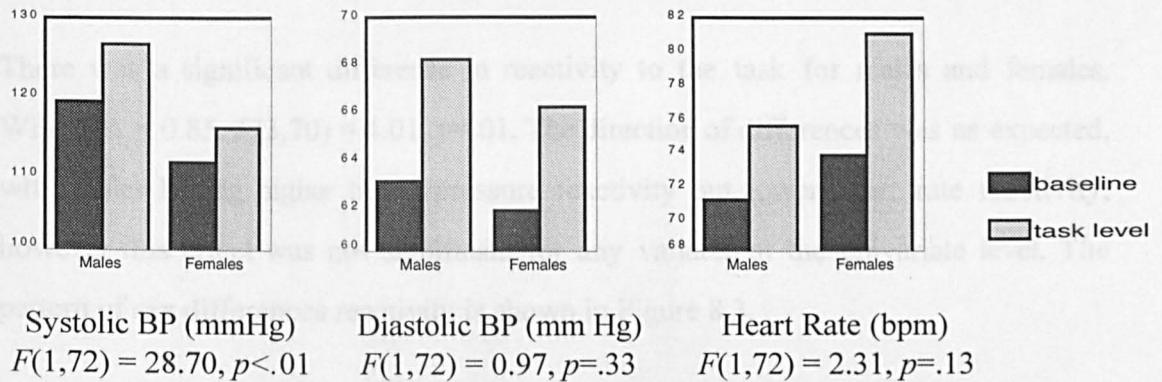


Figure 8.2 The effect of participant's sex on cardiovascular variables

There were no main effects of allocation to either DOG or TALK factors: DOG, Wilks's $\Lambda = 0.96$, $F(3,70) = 1.08$, $p = .36$; TALK, Wilks's $\Lambda = 0.93$, $F(3,70) = 1.68$, $p = .18$; and no interaction between these terms, Wilks's $\Lambda = 1.00$, $F(3,70) = 0.07$, $p = .98$.

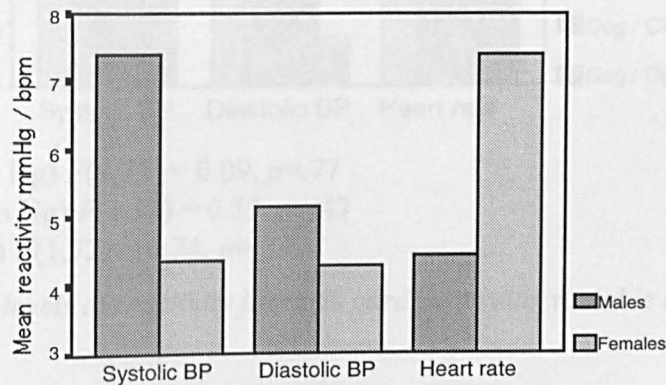
As shown in Table 8.1, baseline diastolic blood pressure differed between the experimental groups and heart rate differences were close to significance. Therefore, an additional MANOVA checked whether baselines were affected by allocation to experimental group. However, when all dependent variables and between-subjects factors were considered together, there was no effect on baselines on either DOG or TALK factor: DOG, Wilks's $\Lambda = 0.92$, $F(3,70) = 1.90$, $p = .14$; TALK - Wilks's $\Lambda = 0.92$, $F(3,70) = 2.15$, $p = .10$; and no interaction between them, Wilks's $\Lambda = 0.99$, $F(3,70) = 0.27$, $p = .85$. Therefore, no further action was taken to include baseline levels in analyses of reactivity.

8.3.2.3 The effect of the task (reactivity)

The math task was effective in significantly increasing cardiovascular measures, Wilks's $\Lambda = 0.49$, $F(3,70) = 24.66$, $p < .01$. Subsequent univariate tests indicate that

this effect was significant for all three variables. The task caused average increases in systolic blood pressure of 5.3 mmHg ($SD=6.5$), diastolic blood pressure 4.6 mmHg ($SD=5.4$) and heart rate of 6.5 bpm ($SD=7.1$).

There was a significant difference in reactivity to the task for males and females, Wilks's $\Lambda = 0.85$, $F(3,70) = 4.01$, $p=.01$. The direction of differences was as expected, with males having higher blood pressure reactivity but lower heart rate reactivity, however this effect was not significant for any variable at the univariate level. The pattern of sex differences reactivity is shown in Figure 8.3.



Systolic BP (mm Hg) $F(1,72) = 3.54$, $p=.06$

Diastolic BP (mm Hg) $F(1,72) = 0.44$, $p=.51$

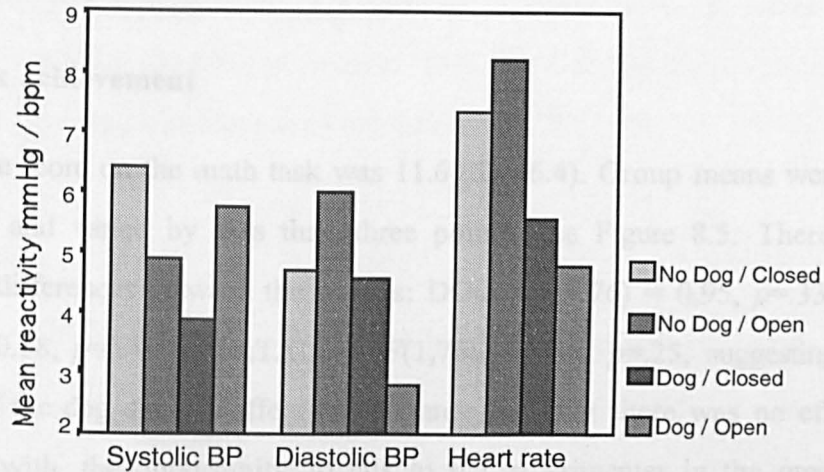
Heart Rate (bpm) $F(1,72) = 3.02$, $p=.09$

Figure 8.3 Mean levels of male and female reactivity to the task.

8.3.2.4 Group differences in reactivity

The reactivity for each experimental group is shown in Figure 8.4. If the presence of a dog produces a form of stress moderation, then a main effect of DOG would be expected with lower reactivity in the dog present conditions. If this moderation depended in some manner on the social interaction, then it might be expected that there would be an interaction between factors of DOG and TALK, with stress moderation effects seen only or in a stronger form in the dog present and open interaction condition than the other experimental conditions. There was no evidence

for this pattern: no significant effect on reactivity of DOG, Wilks's $\Lambda = 0.96$, $F(3,70) = 1.06$, $p=.37$; or TALK, Wilks's $\Lambda = 0.99$, $F(3,70) = 0.35$, $p=.79$. The interaction between these factors was also non-significant, Wilks's $\Lambda = 0.92$, $F(3,70) = 2.07$, $p=.11$.



Systolic BP (mm Hg) $F(1,72) = 0.09$, $p=.77$

Diastolic BP (mm Hg) $F(1,72) = 0.53$, $p=.47$

Heart Rate (bpm) $F(1,72) = 0.74$, $p=.39$

Figure 8.4 Mean levels of reactivity for each cardiovascular variable by experimental group.

There were no other significant effects or higher order interactions within the MANOVA. Given the concern regarding the uneven baseline levels of participants, separate univariate analyses with baseline levels of heart rate and diastolic blood pressure included as covariates were conducted. The results of these analyses were substantially similar, as shown in Appendix N, suggesting that MANOVA analyses did not mask any important effects.

8.3.3 Subjective anxiety

State and trait anxiety scores were computed according to guidelines in the test manual (Spielberger, 1983). There was missing data for one participant who missed out more than one question. As shown in Table 8.1, the trait anxiety scores of the participants

did not differ between the groups. A DOG x TALK ANOVA was used to see if state anxiety differed significantly between experimental conditions. State scores did not differ between the groups: DOG - $F(1,75) = 1.15, p=.29$; TALK - $F(1,75) = 0.07, p=.80$; DOGxTALK - $F(1,75) = 0.29, p=.59$, suggesting that there was no differential effect of the conditions on state anxiety levels.

8.3.4 Task achievement

The average score on the math task was 11.6 ($SD=6.4$). Group means were close to each other and varied by less than three points, see Figure 8.5. There were no significant differences between the groups: DOG - $F(1,76) = 0.95, p=.33$; TALK - $F(1,76) = 0.18, p=.68$; DOGxTALK - $F(1,76) = 1.33, p=.25$, suggesting that the presence of the dog did not affect performance and that there was no effect of, or interaction with, the opportunity to talk to the experimenter in the greeting stage (TALK).

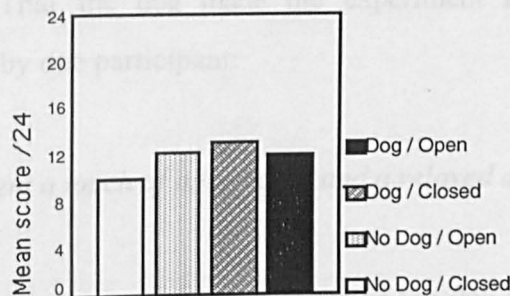


Figure 8.5 Math scores by group.

8.3.5 Subjective evaluations

A number of explanations for any potential stress reducing effects of a dog were proposed. These included, a) the dog acting to reduce the threat of the situation, b) the dog acting to modify the participants' perception of the experimenter, c) the dog promoting positive communication between participant and experimenter, d) the dog acting as a focus for attention / distraction, and e) relaxation of participant, or expectation of being relaxed in response to perceived demand characteristics of the

experimental setting. The brief questionnaire used in experiment two did not find any condition differences for the presence of a dog on threat ratings of the experimental setting (5 items), positive perception of experimenter (1 item), or distraction from the task (1 subjective rating and 1 performance score). The questionnaire in the current experiment was more complex, with 4 items assessing threat of the setting, 6 items assessing the perception of the experimenter, 2 items assessing social interaction variables, 3 variables assessing distraction / focus provided by the presence of the dog and 2 items assessing expectations of relaxation.

8.3.5.1 Threat of setting

It was expected that the presence of the dog might affect the perceived threat of the experimental situation by making the setting appear less formal and more humorous, although the previous experiment had not found any evidence for this suggestion. Group means are shown in Table 8.3, with a summary of effects of DOG and TALK factors in Table 8.4. That the dog made the experiment seem less formal was specifically mentioned by one participant:

S8 *"it gave the experiment a touch of informality and a relaxed atmosphere"*

In this experiment, there were no significant effects of the dog condition on ratings of formality or seriousness, although there was a very weak trend for people to rate the experiment as less serious in the dog present condition. Overall the experiment was judged to be significantly more pleasant in the dog present conditions. The effect of the use of the script did however produce a strong effect on rating the experiment as significantly more formal and as being more serious. The presence of the dog did not modify these or any of the other ratings of the talk conditions; there was no significant interaction between DOG and TALK factors on any of the ratings.

Table 8.3 Participants' threat ratings

Item	Scale anchor points		Dog absent		Dog present	
	1=	6=	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20
Experimental setting was	very formal	very informal	3.10 (1.15)	2.70 (0.96)	3.30 (0.96)	2.75 (1.46)
Viewed experiment as	very important	very trivial	3.15 (1.18)	2.90 (0.62)	2.95 (0.68)	2.90 (1.46)
Found experimental situation	very unpleasant	very pleasant	3.26 ^a (1.05)	3.72 ^b (1.04)	4.05 (1.10)	3.83 (0.77)
Experimental setting was	very humorous	very serious	4.45 (0.69)	5.00 (0.84)	4.20 (0.59)	4.65 (0.98)

Note. Group means with standard deviations in parentheses are shown.

a= data lost for one participant, b= data lost for two participants

Table 8.4 Effect of dog and talk factors on threat ratings.

Item	Effect of Dog	Effect of Talk	Interaction
Formality	$F(1,76) = 0.28, p=.60$	$F(1,76) = 3.99, p=.05$	$F(1,76) = 0.10, p=.75$
Triviality	$F(1,76) = 0.19, p=.66$	$F(1,76) = 0.43, p=.51$	$F(1,76) = 0.19, p=.66$
Pleasantness	$F(1,73) = 3.80, p=.05$	$F(1,73) = 0.26, p=.61$	$F(1,73) = 2.25, p=.14$
Seriousness	$F(1,76) = 2.50, p=.12$	$F(1,76) = 6.95, p=.01$	$F(1,76) = 0.07, p=.79$

8.3.5.2 Perception of experimenter

One of the aspects of the setting to be examined was the suggestion that the presence of a dog would positively influence the participants view of the experimenter. Six aspects of the experimenter's demeanour were examined, likeability, friendliness, amateurism, ability to relax the participant, reassurance and nervousness. Group means are shown in Table 8.5 with a summary of effects of DOG and TALK factors in Table 8.6. Friendliness, amateurism, nervousness of the experimenter and ability to relax the participant were judged not to vary between conditions. However, the

groups with the dog present found that the experimenter was significantly more reassuring, and more likeable. This would seem to confirm the suggestions that the presence of a dog positively affects people's perceptions of the person associated with the dog.

Participants tested in the closed social interaction conditions did not rate the experimenter significantly different to those in the open conditions, although there was a tendency for the experimenter to be rated as less professional in manner in the closed conditions. There was no interaction between the dog and talk factors on any rating.

Table 8.5 Participants' perceptions of the experimenter

Item	Scale anchor points		Dog absent		Dog present	
	1=	6=	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20
Experimenter was	very intimidating	very reassuring	4.10 (0.72)	4.20 (1.15)	4.60 (1.05)	4.80 (0.95)
Experimenter was	very likeable	not at all likeable	2.95 (0.83)	2.84 ^a (0.96)	2.65 (0.88)	2.30 (0.80)
Experimenter made me feel	very relaxed	very much on edge	3.25 (1.02)	2.89 ^a (1.10)	2.85 (0.93)	2.60 (0.94)
Experimenter seemed	very relaxed	very nervous	2.40 (1.19)	1.89 ^a (0.81)	2.00 (0.97)	1.85 (0.67)
Experimenter was	very friendly	very unfriendly	2.75 (0.91)	2.89 ^a (1.05)	3.00 (1.30)	2.45 (1.15)
Experimenter seemed	very professional	very amateur	2.10 (0.91)	1.74 ^a (0.65)	2.10 (0.79)	1.80 (0.77)

Note. Group means with standard deviations in parentheses are shown.

^a= data lost for one participant.

Table 8.6 Effect of dog and talk factors on experimenter ratings

Item	Effect of Dog	Effect of Talk	Interaction
Reassurance	$F(1,76) = 6.30, p=.01$	$F(1,76) = 0.47, p=.82$	$F(1,76) = 0.05, p=.82$
Likeability	$F(1,75) = 4.67, p=.03$	$F(1,76) = 1.38, p=.24$	$F(1,76) = 0.39, p=.54$
Ability to relax	$F(1,75) = 2.39, p=.13$	$F(1,76) = 1.81, p=.18$	$F(1,76) = 0.05, p=.82$
Nervousness	$F(1,75) = 1.12, p=.29$	$F(1,76) = 2.44, p=.12$	$F(1,76) = .072, p=.40$
Friendliness	$F(1,75) = 0.15, p=.70$	$F(1,76) = 0.66, p=.42$	$F(1,76) = 1.93, p=.17$
Amateurism	$F(1,75) = 0.03, p=.86$	$F(1,76) = 3.50, p=.07$	$F(1,76) = 0.03, p=.86$

8.3.5.3 Social catalysis

There have been suggestions that some stress moderation might occur due to increased social interaction as prompted by the presence of a dog. This experiment explicitly tested this hypothesis by allowing some participants the opportunity for conversation prior to the start of the experiment where the presence of a dog might act as an additional ice-breaker (open conditions) whereas other participants were greeted outside the experimental room so that no social interaction was expected to occur (closed condition). As a check on the effectiveness of the manipulation, participants were asked to rate the experimenter for her talkativeness and the ease with which they felt they could talk to her. Group means are shown in Table 8.7, with a summary of effects of DOG and TALK factors shown in Table 8.8. Generally the experimenter was rated as not being very communicative towards the participants. The participants' perceptions of their ability to talk to the experimenter were more moderate. The effect of the social catalysis manipulation did not result in significantly different ratings on these two factors.

Table 8.7 Participants' perceptions of the social interaction

Item	Scale anchor points		Dog absent		Dog present	
	1=	6=	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20
Found the experimenter	very chatty	not at all talkative	4.85 (1.39)	4.47 ^a (1.22)	4.90 (1.07)	5.25 (0.85)
For me to talk to experimenter was	very easy	very difficult	3.75 (1.25)	3.79 ^a (1.40)	4.30 (1.30)	4.00 (1.52)

Note. Group means with standard deviations in parentheses are shown.

a= data lost from one participant.

Table 8.8 Effect of dog and talk factors on social interaction ratings

Item	Effect of Dog	Effect of Talk	Interaction
Experimenter talkative	$F(1,75) = 2.91, p=.09$	$F(1,75) < 0.01, p=.96$	$F(1,75) = 2.25, p=.14$
Ease to talk to experimenter	$F(1,75) = 1.56, p=.22$	$F(1,75) = 0.18, p=.67$	$F(1,75) = 0.31, p=.58$

It was important to check that all participants saw the dog as soon as they entered. Obviously, it would not be feasible to expect the presence of a dog to influence the introductory part of the experiment if the participant was unaware of its presence until the experiment had started. The dog in the experiment had been trained not to solicit attention and also the experimenter did not draw attention to its presence or comment on it. Of the 20 participants who were greeted in the experimental room with the dog present, 13/20 reported seeing the dog as they entered the room. Twenty three percent (3/13) made a comment on the dog at this stage. Comments were quite brief and were rhetorical 'ooo doggie' or 'aah' types and did not lead to further conversation about dogs. Reasons given by participants who did not comment on the dog despite seeing it at the start of the experiment ranged from; thinking it was part of the experiment (5), part of another experiment (1), belonged to the experimenter and

so not odd (1), or were shocked and unsure of why the dog was there (1) or just not talkative (2). Comments on topics other than dogs ranged from: being late, specific weather problems, health conditions, problems with forgetting sign in sheets (for student participants) and other miscellaneous comments which were evenly spread between the conditions. No participant engaged in what could be called a normal conversation with the experimenter prior to the experiment and most seemed just to be keen to get on with the experiment. None of the participants in the scripted condition commented on the dog when they entered the experimental room.

An independent rater listened to a random selection of 10 recordings in each condition. Where, a recording was judged to be of too poor a quality to make confident judgements, a random substitute from the same condition was given: poor recording quality led to rejection of 11/51 recordings.

Recordings were rated for deviation from the script on a three point scale; 1= minimal, 2= reasonable, but more than minimal and 3= substantial deviation.⁸ No recording was rated as a large deviation from the script and the deviation ratings did not differ across conditions ($H(3, N=40) = 1.10, p = .78$). In cases where deviation occurred, this was due to questions or statements raised by the participant in regard to clarification of instructions (15) or requests as to location of the toilet (2), the resultant conversations were short and did not deviate from answering the request.

The tone of the greeting conversation was also rated on a three point scale; 1= specifically unfriendly, 2= business like, 3= specifically friendly.⁹ All recordings were

⁸ A no deviation category was initially proposed, but it was found that the experimenter never stuck exactly to the script, but would often deviate by one or two words in a sentence, or reversed the order of a pair of sentences. This was classed as minimal deviation. However and importantly, in all cases the same points of information were presented in the same order. Category two deviation reflected utterance of a non scripted sentence or repetition of one previously made point at the request of the participant. Category three deviation was utterance of two or more non-scripted points or more than one repetition of a previous point(s). The random order in which participants in each condition were tested would have guarded against any effect of the experimenter becoming more or less adept at sticking to the script over the course of the study, however there was no evidence for this effect anyway.

⁹ Expansion of the rating scale to 4 or 5 points was discussed with the rater, but this was deemed not to make any difference as all tapes were so similar.

rated as business like. Although the rater knew that 20 of the recordings were from dog present conditions, she was not able to confidently identify any of the recordings as being from a different condition to any of the others.

The conversation duration on the recordings was timed. The greeting period was timed from the first word spoken to start of the instruction not to speak, just prior to the start of the cardiovascular measurements. This time was exclusive of the time spent by the participant filling in the demographic questionnaire and trait anxiety inventory. Greeting period duration is shown in Figure 8.6. Participants in the closed condition were required to move approximately 20 feet from an ante-room to the main experimental room during this time and thus in this condition the greeting period was significantly longer, by approximately 10 seconds $F(1,36) = 7.69, p < .01$. However, in neither the open nor closed conditions did dog presence affect the duration of the greeting period $F(1,36) = 1.10, p = .30$. There was no general effect for conversations to be longer in the dog present conditions $F(1,36) = 1.62, p = .21$.

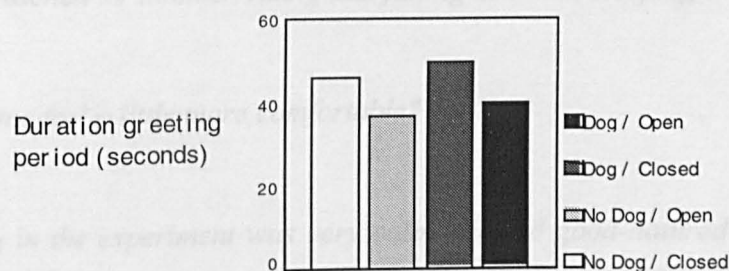


Figure 8.6 Mean duration of greeting period

Thus it did not seem that the presence of the dog provoked social interaction in a setting such as this, although this may well have been limited by participant type and failure to notice the dog in the greeting stage of the experiment.

8.3.5.4 Focus

It had been proposed that the presence of a dog might serve as a source of focus and attention during the rest period which might prevent participants in the dog present groups becoming bored and restless which would increase cardiovascular activity. There was some evidence that the presence of the dog influenced participants' thoughts during the rest period, as 10/40 participants, (25%), stated that they had thought about the dog. The absence of dog type comments would not be evidence that participants had not thought about the dog and it would not be surprising if participants thought about the dog as it was a salient feature of an otherwise fairly sparsely furnished room. Some participants made positive comments about the dog:

S10 *"I was watching the dog twitching whilst sleeping and wondering what it was thinking about"*

S57 *"the dog was extremely sleepy during the experiment which did make me feel relaxed as I watched its stomach rising and falling as it was sleeping"*

S78 *"it made me feel a little more comfortable"*

S80 *"this dog in the experiment was very calm, seemed good-natured and had a soft face - therefore relaxing"*

However, in general it was not possible to evaluate from the nature of comments whether the participants in the dog present groups had had more positive thoughts than those in the dog absent group.

The presence of the dog did not make any difference to the evaluation of the setting as relaxing during the rest period, see Table 8.9, or to the numbers of participants stating that the rest period was too long ($\chi^2(1, N=79) = 0.30, p = .58$). Thus it did not seem

that the dog acted as a source of focus or distraction for participants during the rest period.

Table 8.9 Participants' distraction ratings

Item	Scale anchor points		Dog absent		Dog present	
	1=	6=	Closed <i>n</i> =20	Open <i>n</i> =20	Closed <i>n</i> =20	Open <i>n</i> =20
Setting relaxing in rest period	not at all relaxing	very relaxing	3.60 (1.35)	3.70 (1.30)	4.10 (0.97)	3.65 (1.35)
Concentration on math task	easy to concentrate	not easy to concentrate	4.10 (1.77)	3.40 (1.73)	3.30 (1.92)	3.65 (1.84)
Effort put into task	extreme effort	no effort at all	3.55 (1.36)	2.95 ^a (1.08)	2.65 (0.99)	3.20 (1.28)

Note. Group means with standard deviations in parentheses are shown.

^a= data lost for one participant.

Table 8.10 Effect of dog and talk factors on distraction ratings

Item	Effect of Dog	Effect of Talk	Interaction
Setting relaxing	$F(1,76) = 0.64, p=.42$	$F(1,76) = 0.39, p=.53$	$F(1,76) = 0.96, p=.33$
Concentration on task	$F(1,76) = 0.46, p=.50$	$F(1,76) = 0.19, p=.67$	$F(1,76) = 1.67, p=.20$
Effort put into task	$F(1,75) = 1.47, p=.23$	$F(1,76) < 0.01, p=.92$	$F(1,76) = 4.65, p=.03^*$

*= no two groups differ at $p<.05$.

Distraction during the task period did not seem apparent in objective performance terms, as noted in Section 8.3.4. This was mirrored by no differences in the ratings of ability to concentrate on the maths task between the conditions, see Table 8.9 and Table 8.10. For effort put into the task, the interaction term was significant, participants in the closed, dog absent group gave ratings of much lower effort in the maths task than the other groups, but no two groups differed significantly on post hoc

Tukey tests.

8.3.5.5 Expectation of stress reduction

The stress reducing properties of pets are often alluded to, therefore it was suspected that some participants might, on seeing the dog, expect to be relaxed and therefore affect their own physiology. Participants were asked what they thought the experiment was about, see Table 8.11. The majority, correctly surmised that the experiment concerned effects of stress on physiological indices, 18% of those in the dog present condition thought the purpose of the experiment was to see if the dog relaxed them.

Table 8.11 Participants' theories on the purpose of the experiment

Purpose	<i>n</i>	%
Stress and blood pressure	59	74
Stress and personality	4	5
Stress	3	4
Stress and performance	3	4
Stress and health	1	1
Kept a blank mind	1	1
Missed out question	2	3
Effects of the dog on stress	7	9

When asked directly why they thought the dog was there, most people, 78% thought it was there to see *whether* it relaxed people, however 12% of people thought its purpose *was* to help relax people for the purposes of either gaining more accurate blood pressure measurements or making them feel more at home.

Participants were asked to rate their expectation that they would be relaxed by the dog and also whether they felt they had been relaxed by the dog. Thirty five percent of participants indicated that they expected to be relaxed by the dog and forty three

percent felt that they actually had been relaxed by the dogs' presence. However, these feelings did not relate at all to the physiological reactivity to the task or the self reported stress to the task on the state anxiety scale, see Table 8.12. Thus although some participants may have expected to have been relaxed, this did not affect their physiological reaction to the experiment.

Table 8.12 Levels of cardiovascular reactivity and state anxiety by whether participants expected to be or felt they were relaxed by the dog's presence

	Non-dog conditions	Expected to be relaxed by dog			Analysis
		Yes	Maybe	No	
SBP reactivity	5.7	5.7	4.6	4.2	$F(3,76) = 0.21, p=.88$
DBP reactivity	5.4	3.6	4.1	3.3	$F(3,76) = 0.67, p=.57$
HR reactivity	7.8	5.9	5.7	3.6	$F(3,76) = 1.15, p=.33$
State anxiety	49.1	47.6	46.1	43.9	$F(3,76) = 0.56, p=.65$

	Non-dog conditions	Felt was relaxed by dog			Analysis
		Yes	No	Don't know	
SBP reactivity	5.7	5.7	5.7	3.1	$F(3,76) = 0.57, p=.63$
DBP reactivity	5.4	4.1	3.9	3.1	$F(3,76) = 0.71, p=.55$
HR reactivity	7.8	5.4	4.1	5.9	$F(3,76) = 1.02, p=.39$
State anxiety	49.1	45.1	45.8	47.4	$F(3,76) = 0.47, p=.70$

8.3.6 Attitude to dogs

Friedmann, Locker and Lockwood (1993) found that participants who evidenced more positive attitudes to dogs had lower cardiovascular reactivity in the presence of a dog than those people who had less favourable attitudes to dogs. Attitudes to dogs in their study was examined by seeing how the presence of a dog changed ratings of people in pictures with or without dogs. In the previous two studies in this series, due to the small numbers of participants being tested in the presence of the dog, when other important variables such as sex and age were added, analyses were either not possible due to empty cells, or of low power. The current experiment provided a more ideal

opportunity, with a larger number of people tested with the dog and a highly homogenous sample with respect to age. The experiment also assessed attitudes to dogs in general and to the specific dog used in the experiment.

Attitudes to dogs in general was assessed on a seven point scale with the middle option being 'no feelings about dogs'. Attitude towards the experimental dog was also canvassed, except this time, the 'no feelings' option was omitted so that participants were forced into either a positive or negative attitude choice. As shown in Table 8.1, p.216, general attitude towards dogs did not vary significantly by group, although one of the dog absent groups had a much more negative attitude to dogs than the other experimental groups.

Attitude to the experimental dog was dichotomised into high and low ratings - these cannot really be termed positive and negative groups, as the low ratings group combined those who stated they 'liked having the dog there' and those who 'tolerated its presence' whereas the high attitude group answered 'liked having it there a lot' and 'intensely liked having it there'. Baseline levels did not differ by attitude towards the experimental dog, systolic blood pressure $F(1,36) = 0.49, p=.49$, diastolic blood pressure $F(1,36) = 0.25, p=.62$ and heart rate $F(1,36) = 0.05, p=.83$. Reactivity was not different between the attitude groups for systolic blood pressure $F(1,36) = 0.03, p=.85$, or diastolic blood pressure, $F(1,36) = 0.23, p=.63$, however, reactivity for those who liked the experimental dog most was significantly lower than for those who reported only a moderate liking for the dog $F(1,36) = 6.71, p=.01$.

8.4 Discussion

The fundamental finding in this study was that there was no difference in either baseline or reactivity levels in the presence of a dog. Therefore a third experiment has failed to find a stress moderating effect of an unfamiliar dog on adult cardiovascular reactivity. In addition the expected interaction between factors of dog presence and opportunity for social catalysis was not found. This suggest that the stress moderating effect is not masked when social interaction and any social catalysis effect of a companion animal is controlled. The power of this study to detect a large size effect was 0.93, and there was an adequate i.e. .80 power to detect effects as small as $d=.32$, therefore the failure to detect an effect does not seem attributable to low power.

However, there did not appear to be an effect of the dog promoting social interaction in the laboratory setting. This is a robust effect in other settings and just because it was not shown to affect this type of study, does not mean that it may not affect experiments based in a home setting, or using the participant's own dog. Not all the participants saw the dog in the greeting phase of the experiment, it was not surprising that some participants might not notice the dog, as the dog was frequently asleep and the experimenter did not draw attention to him. However it was surprising that so many (35%) participants did not see the dog. If the participant did not see the dog then there can be no likelihood that its presence can affect the social interaction. The nature of the young participants tested in this study may have affected the likelihood of detecting this effect. The majority of participants were not volunteers, but were participating for course credit in a research methods course, the alternative being a written assignment. The participants appeared uncommunicative and not interested in the experiment even when directly questioned by the experimenter in a debriefing session, so unlikely to spontaneously comment in the greeting phase of the study.

However the participants tended to rate the experimenter as being less talkative in the dog present conditions. This raises the possibility that the experimenter was over compensating in the dog conditions in an effort not to prove her own hypothesis and thus was less open to any social catalysis effects which might have occurred. Mitigating against this suggestion are the more positive ratings that were given to the experimenter in the dog present conditions, that an independent judge listening to the tapes did not rate the tone of the greeting phase or deviation from script as particularly different in any condition, and that the time length of the conversations did not differ across conditions. It does however highlight that the behaviour of the experimenter is an important consideration. The experimenter cannot be blind to the dog condition and taping conversation does not pick up on the many non-verbal cues which can be exchanged and which might increase rapport. Ambady and Rosenthal (1992) highlight that much of the non-verbal behaviour on which people make judgements about us, is unintended and below a conscious level. Therefore it would be difficult to guard against this effect.

Taping the conversation was not an optimum method of monitoring the interaction, as the tape recorder was on the table and not always able to pick up the entering comments which took place approximately 20 feet away and were often muffled by other activities. Therefore it would be recommended that if further examination of social catalysis issues is undertaken, more sophisticated sound equipment is employed and that video is used as a more comprehensive monitoring method.

The participants tested in the presence of the dog tended to rate the experiment as being more humorous and as significantly more pleasant than those tested in dog absent conditions. The social catalysis manipulation, not surprisingly, meant that participants rated the study as being more formal and more serious. This gives some weight to the suggestion that the presence of a dog may affect the threat rating of the experiment. Spontaneous comments made by participants in response to some of the open questions also highlighted the ability of the dog to make the situation less

clinical, giving the study a touch of informality and making the participant feel more at home. It may be that the rating questions were not sensitive enough to pick up on differences between individual participants. To assess this type of mechanism, a within-subjects design may be more appropriate and sensitive.

The experimenter was rated significantly more positively on ratings of likeability and being reassuring, in the dog present conditions. This confirms previous findings of Rossbach and Wilson (1992) and Lockwood (1983) suggesting that people associating with a companion animal may be perceived more positively. The current experiment however extends their findings, as they asked participants to rate pictures, whereas in the current study the participants actually interacted with the person who was either with or without the dog. This more positive appraisal of people with animals may underlie the effects of social catalysis and stress moderation from an unfamiliar animal. However it should be noted that in the current study, there was no evidence of either increased social interaction in the presence of a dog, or of any moderation in either physiological or psychological indices of stress.

It did not seem that the presence of a dog acted as a focus of attention during the rest period, as ratings of the relaxing aspects of the setting and boredom did not vary with its presence. If the presence of a dog provided some distraction to participants, this was unable to influence ratings over and above the effect of sitting in a bare laboratory for 20 minutes doing nothing. Objective performance on the math task did not differ across conditions, this supports findings of the previous studies in this series which found no performance differences in the presence of a dog as compared to an alone condition. Previous studies in the companion animal literature have also not found performance differences (e.g. Allen *et al.*, 1991; Straatman *et al.*, 1997). However this experiment demonstrates that there are no subjective feelings of distraction either.

Expectation of relaxation also did not affect any physiological variable. Although 35% of participants stated that they expected to be relaxed by the dogs presence there was

no difference in the reactivity or baseline levels of people who stated they were or were not relaxed.

Participants with more positive attitudes towards the experimental dog had significantly lower heart rate reactivity than those with more negative attitudes. This confirms Friedmann, Locker and Lockwood's (1991) findings, that those with more positive attitudes towards dogs tend to have lower reactivity than those with negative attitudes. Although Friedman, Locker and Lockwood found effects on blood pressure but not heart rate, whereas the current study only found effects on heart rate. There seems no explanation as to why the studies found effects on different variables. In part this may be due to the method of attitude assessment. In the current experiment attitude to the dog used in the experiment was assessed, whereas in the Friedman, Locker and Lockwood study, it was a generic attitude to animals. Alternatively it may be that the relationship found in the current study was just a spurious effect. In either case, this effect should be replicated before it is accepted as robust. However it does suggest that any stress moderation which may occur due to the presence of an unfamiliar dog is heavily dependent on the participants' attitude to the animal present.

8.4.1 Conclusion

The current study has found a number of changes in participants' perceptions when a dog is present. Specifically, the experiment is rated as being more pleasant and the experimenter as being more reassuring and more likeable in the presence of the dog. Many ratings however were not different between conditions and this raises the possibility of whether the significant effects were a spurious consequence of the multiple comparisons being made. Attempts should be made to try and replicate all of these effects before they are accepted as robust. As there was no stress moderation in this study, it is not possible to unambiguously accept that these changes in perception underlie stress moderation effects seen in other studies. Likewise, it is not possible to accept that the ratings which were not found to change do not change in situations

where stress moderation occurs and are part of the mechanism behind the effect.

However, the previous three experiments have demonstrated that stress moderation from the presence of an unfamiliar dog is not a robust finding. The inability of studies to detect this effect does not appear to be attributable to poor methodology, nor to lack of power. The current study has shown that it is not simply masked when social interaction between participant and experimenter is standardised. Therefore other aspects of the design must come under scrutiny. In sections 6.1.1-6.1.5, a number of options were considered, location, animal type, etc. For the first experiment in this series, a pragmatic combination was chosen which would allow control of as many variables as was possible. However with the repeated inability to detect any effects, a major rethink is required. A further study using the same combination, published after the conception of these three experiments, also produced non-significant results (Straatman *et al.*, 1997). It would seem prudent therefore in future experiments to re-examine design choices and not to try a further experiment with an essentially similar design.

Chapter Nine

Experiment Four - Comparison of human and animal companions

9.1 Introduction

The three previous studies have failed to find any suggestion of stress moderation from an unfamiliar animal, using adult participants tested in a standardised university laboratory and with exposure to the dog as a between-subjects factor. Several refinements to methodology and an increase in power have failed to suggest even a small sized effect, and therefore it would seem wise to pursue this formula no longer. There was a slight suggestion in the third experiment that stress moderation may be reliant on the participant's attitude towards the animal. Therefore in this experiment it was decided to explore issues with the person's own pet. As the aim was to explore mechanisms which might occur in these situations, it was decided to test people in the university laboratory to provide the control and standardisation of conditions.

9.1.1 Stress moderation from ones own pet

Only the experiments of Grossberg, Alf and Vormbrock (1988), Allen *et al.* (1991) and Rajack (1997) have examined moderation of reactivity in the presence of the participant's own pet. Neither Grossberg, Alf and Vormbrock (1988) nor Rajack (1997) found any stress moderation effect of the pet. Allen *et al.* (1991) found a stress moderation effect of the person's own pet only on systolic blood pressure with lower reactivity in the pet present condition as opposed to an alone condition or a friend present condition. In contrast to all other studies on human support in a laboratory, the presence of the friend was associated with significantly higher reactivity than the alone condition. Allen *et al.* (1991) concluded that the stress moderation from the

presence of the dog was due to a social support mechanism. Their friend present condition, they concluded, was evaluative in nature and therefore this outweighed the social support element and resulted in increased reactivity.

A number of researchers have suggested that evaluation from a human companion may interfere with the benefits of social support (Allen *et al.*, 1991; Gerin *et al.*, 1995; Kamarck *et al.*, 1995; Snyder-Smith & Cacioppo, 1992). This suggestion seems intuitively plausible and might explain why some studies have found an effect and others have not. However an experiment which explicitly tested this, found that people tested in the presence of an evaluative friend did not evidence any greater reactivity than those tested alone or in the presence of a non-evaluative friend (Kors *et al.*, 1997). Thus it does not seem that a non-evaluative companion is the only limiting factor.

Experimenters have found experimental support for the hypothesis that the effects of a passive human social support depend not only on the elimination of evaluation potential but also on it being a high threat situation (Gerin *et al.*, 1995; Kamarck *et al.*, 1995). Therefore, the experiment of Allen, carried out in a home setting, might not be expected to show an effect of human social support, even had the evaluation component been removed. It is unclear under what conditions a canine presence might convey social support if a human presence might not and therefore the Allen experiment does not unambiguously establish that the mechanism underlying the reduction in moderation in stress from a companion animal presence is social support.

There is scope for a further experiment to try to replicate this effect whilst including suitable methodological improvements given the mixed results of other research. Additionally other explanations which are not bound into social support such as expectation of relaxation, distraction and social catalysis need to be examined. A social support mechanism seems to be accepted by default in studies of human companions. However, self-report items which purport to measure social support have not found

differences between conditions. For example, Kamarck *et al.* (1995) using questions design to tap aspects of task related social support found no condition differences. Therefore it is important to carefully examine other explanations which might account for the condition differences in reactivity before a social support explanation is accepted.

One particular explanation which seems relevant to a study with a companion animal is the effect of distraction. Distraction-conflict theory (Baron, 1986) suggests that presence of an observer should increase arousal due to the uncertainty surrounding the actions of the observer. Some of this may stem from the evaluation potential of the audience. However, distraction is not a unique property of human observers and Baron (1986 p.8) suggests that 'social facilitation' and by implication distraction might be produced by a mannequin or even by the presence of a well trained dog. Generalising from the social facilitation literature, the arousal produced by distraction might be expected to facilitate performance of easy tasks and interfere with successful performance of difficult tasks (Zajonc, 1965). Therefore studies should be able to use performance as a proxy for distraction.

Although a number of studies have examined performance as an index of distraction, some have the rationale underlying this seems uncertain. Whether distraction should facilitate or inhibit performance would seem reliant on the properties of the task. Some studies have examined whether there were performance decrements in their 'friend present' as opposed to an 'alone' condition to rule out the *stress moderation* from a familiar companion (cf. Kamarck *et al.*, 1990 p.52). Other researchers highlight distraction as a possible cause of increased arousal from a in a companion present as opposed to alone condition (Lepore *et al.*, 1993; Snyder-Smith & Cacioppo, 1992). These studies find no performance differences across conditions and therefore conclude that distraction is not occurring. What appears to be lacking in these studies is some subjective measure of distraction which might resolve the question of whether participants are distracted.

Given the suggestion by Kamarck *et al.* (1995) and Gerin *et al.* (1995) that high threat is a boundary condition for social support effects to be seen, it would be of interest to see whether threat ratings were affected by the presence of a companion. Although Kamarck *et al.* made this suggestion, the threat items they used were sensitive to their formality manipulation, but were not affected by presence of a companion.

Comparing a human companion condition with a companion animal condition allows examination of whether similar mechanisms might underlie both human and canine moderation of reactivity.

9.1.2 Examination of recovery

It was decided in this experiment to extend the scope of the previous designs by considering effects on both reactivity to and recovery from a stressor. The study of recovery to stress is relatively less developed than the study of reactivity. However it has recently received more attention as researchers have been able to collate sparse results (Haynes, Gannon, Orimoto, O'Brien, & Brandt, 1991; Hocking Schuler & O'Brien, 1997; Linden *et al.*, 1997). The rationale for examining recovery, is that a prolonged recovery is an index of an excessive stress response which may lead to aversive health outcomes if repeated over time.

9.1.3 Task choice

The main barrier to study of recovery indices is the selection of a task with a sufficiently prolonged recovery profile to enable condition differences to be examined. From their own previous research, Linden *et al.* (1997) have found that the majority of participants recovery quickly from most tasks and it is only tasks which provoke anger which regularly have a long recovery profile.

The two goals of the study - to examine social support type effects and to examine recovery effects - lead to potentially conflicting task choices. As noted the support

paradigm examined in this study was necessarily that of a passive companion. This means that the companion must not be able to evaluate the participants' performance. Although other studies have used participants wearing headphones, pilot testing showed that the volume level required to prevent a person hearing the verbal performance of a task was uncomfortable and the participant may not be convinced that their friend could not hear their performance anyway and so would still feel evaluated. Soundproof booths were not available, therefore it seemed that task choice was limited to those with non-verbal / non-audible performance.

A potential task which was designed to induce feelings of anger was not able to be used due to ethical considerations and safety aspects surrounding making a person angry with their dog present. Therefore it was decided to opt for tasks which induce feelings akin to anger but not as strong and of a non-inter-personal nature. Examination of previous studies suggested that mirror tracing is regarded as a frustrating task (Gillin *et al.*, 1996), additionally this task has successfully been used to discriminate subjects in terms of sex and racial differences in recovery. A second task, a computer game, was selected as a more active task which should also produce frustration due to the nature of the game and equipment. As comparisons between the tasks were not a primary consideration, task order was invariant.

9.1.4 Summary of design

The present study was designed to allow comparison of effects of human and canine companionship on cardiovascular reactivity and recovery. To enhance the ability to detect recovery effects, tasks designed to elicit feelings of frustration were chosen. A number of types of subjective evaluations were examined to see; a) whether the presence of a companion affects threat ratings; b) whether perception of the experimenter was affected by the presence of the companion; c) whether presence of a companion acts as a distractor in either objective performance terms, or in subjective terms; and d) whether presence of a companion affects indices of what might be

termed social support. Comparison of a human companion with a canine companion allows examination of whether similar mechanisms might underlie both human and canine moderation of reactivity and or recovery.

9.2 Method

9.2.1 Participants

The experiment incorporated three between-subjects conditions: a control condition where the person was tested when only the experimenter was present, and two other conditions involving the addition of either the person's pet dog or close friend. To simplify matters, the human participants in the experiment will be distinguished by the terms a) *subject* - the person having their cardiovascular levels measured and b) *friend* - the person accompanying the subject in the friend condition. The number of subjects for the experiment was determined by power considerations. For an 80% likelihood of detecting a large effect, in an ANOVA with three groups, using a two tailed test with α of .05, a minimum of 21 subjects per group were required (Cohen, 1992).

It would have been most desirable to recruit subjects who were willing to take part in any of the experimental conditions and then randomly allocate them to conditions. However, at the design stage, discussions with local dog club experts suggested that only a limited number of dog owners with dogs who met the behavioural criteria lived within the local area.¹⁰ Additionally, it was felt that this small group would be further diminished by asking people to also agree to bring a friend or to come alone, and therefore recruitment would be difficult. To overcome this problem, potential subjects were asked to state which of the experimental conditions they would be willing to take

¹⁰ Subjects were asked if their dog was generally comfortable in unfamiliar situations. They were informed that the testing room was a dog-friendly room and that there would be no worries on the part of the experimenter that the dog would damage the room or equipment. They were asked if they would be comfortable in that situation.

part in. They were informed that it would be most helpful to the experimenter to be as flexible as possible. Subjects were then tested in their chosen condition or allocated to a condition within their restrictions. It was reasoned that subjects not willing or able to take part in all three conditions would either not agree to take part in the study at all or would drop out if allocated to a condition they did not want to take part in, therefore a degree of self-selection would occur anyway.

Ninety adults were recruited from local dog clubs and a local pet food store. None of the participants knew the experimenter before the study. All subjects were dog owners. None of the subjects reported any existing heart or circulatory condition or any conditions which might put them at risk from repeated blood pressure assessments. Subjects were also asked whether they had any health condition which might put them at risk from repeated blood pressure measurement or were on medication which might affect the cardiovascular system. One subject was excluded when post experimental assessment indicated the use of medication known to affect the cardiovascular system.

Criteria for friends were: aged at least 16 years; whom the subject considered a close friend for over 6 months. Relatives were not excluded. Criteria for the dog were; aged over 1 year; with whom the subject considered they had had a close relationship for at least 6 months; who they felt would be comfortable in an unfamiliar situation and who they would be comfortable bringing into an unfamiliar situation. All participants needed to be able to travel independently to the University premises where the testing took place. All participants were offered travelling expenses and subjects were given a small bag of gifts for their dog.

It was anticipated that as subjects were given a free choice as to which condition(s) to volunteer for, the number of subjects volunteering for each condition might be very uneven. Therefore, to assign subjects to conditions, a complex strategy was used of random allocation within constraints and based on proportions of subjects already

tested in each condition, see Appendix O.

Eighteen subjects failed to attend their appointment.¹¹ Additional problems occurred, as two subjects allocated to the friend condition brought both a friend and a dog and so were tested with only their dog present; and one man rescheduled at the last minute to bring his dog with him instead of a friend and so was tested in that condition. Data from five subjects was excluded. As mentioned above, data from one subject in the friend condition was discarded after return of the post-experimental questionnaire by post revealed the use of previously unreported medication that was likely to affect cardiovascular functioning. One subject in the dog condition was unable to complete the tasks due to unfamiliarity with computers. Data from three subjects in the dog condition was excluded due to the behaviour of their dogs. One dog jumped on its owners lap during the second task. Another session had to be repeatedly paused and then terminated early at the request of the owner as the dog was so unsettled. One subject's data was excluded as he brought two dogs instead of one. There were three females and two males amongst the excluded subjects.

The final subject pool consisted of 21 males and 46 females, their ages ranged from 16-66 years, mean age 41 years ($SD= 13.2$) The subject constraints and allocation to conditions are shown in Table 9.1.

¹¹ Subjects who dropped out were significantly more likely to have been recruited at the pet store site $\chi^2 (1, n=90) = 6.07, p=.01$. As expected more people dropped out of friend and alone conditions, eight in each, whereas only 2 people in the dog condition dropped out. This difference was not significant $\chi^2 (2, n=90) = 4.60, p=.10$.

Table 9.1 Participants' initial condition constraints, initial allocation and final testing condition for experiment four

Subject's choices	Allocated Condition			Total
	Alone	Friend	Dog	
Alone only	1	0	0	1
Friend only	0	1	0	1
Dog only	0	0	2	2
Alone or Friend	1	0	0	1
Alone or Dog	8	0	5	13
Friend or Dog	0	1	1	2
Any	12	23	12	47
Allocation Condition	22	25	20	67
Testing Condition	22	22	23	67

9.2.2 Tasks

9.2.2.1 Mirror tracing

Subjects were instructed to trace the outline the figure of a six point star, with a pen, whilst viewing the star in a mirror. An opaque screen was placed to prevent the subject directly seeing the star or their hand. The subject was urged to trace as quickly as possible, but to try to remain within the 2mm line of the star. A second screen obscured the companion's view of the subject's performance and this was kept in place during testing in all conditions. The number of circuits traced was collected as the performance measure.

9.2.2.2 Computer game

The second task used was a computer game. The computer game selected was simple and easy to learn. It required subjects to 'hit' faces which appeared randomly in a 4x4 grid by moving the mouse pointer on top of them and then clicking. Unhit faces would disappear after a time leaving a '*missed me*' message in the square. The time before

unhit faces would disappear became shorter as the subject's performance improved with practice. To increase the frustration aspect of the task, a mouse was used which was not completely responsive and would sometimes jump or become stuck in its movement. The computer monitor was angled away from the companion to prevent them seeing the subjects performance and its position was kept constant for all conditions. Audible aspects of the game which might provide an indication of performance were disabled. A score generated by the number of targets successfully hit was used as the performance indicator.

9.2.3 Apparatus

An Apple Macintosh IICI computer was used to present the computer game task. A Critikon Dinamap 8100 was used to monitor cardiovascular variables.

9.2.4 Measures

9.2.4.1 UCLA loneliness scale

Loneliness was examined due to the concern that subjects who were more lonely might be less inclined to be tested with a friend present and this may affect physiological reactivity. Subjects were given the revised University of California at Los Angeles (UCLA) Loneliness Scale (Russell, Peplau, & Cutrona, 1980). The scale consists of 20 items which respondents have to answer on a 1 to 4 scale anchored at never and often. The items are worded to reflect satisfaction or dissatisfaction with social relationships e.g. '*there are people I can turn to*', '*I feel left out*'. Questionnaires were scored as per instructions of Russell *et al.* with potential scores ranging from 20 to 80 and higher scores indicating more perceived loneliness. Russell *et al.* found an internal consistency of Cronbach's alpha 0.94, in this study a similar level of consistency was found, Cronbach's alpha 0.90.

9.2.4.2 Quality of Relationships Inventory

All subjects were asked to describe one close human relationship and one close canine relationship. This was either the one with the person / dog they were bringing to the experiment, or the person / dog they would have been most likely to bring had they been in the appropriate condition. Features of the relationships were examined using a modified form of the Quality of Relationships Inventory (QRI) (Pierce *et al.*, 1997). This 25 item inventory was designed to assess factors of support, conflict and depth in a specified human-human relationship. Pierce *et al.* determined the subscale structure of the inventory by factor analysis of respondents data on relationships with their mother, father and friends. The inventory was selected for its specific advantage that the majority of items are still coherent when references to 'this person' are changed to 'your friend' or 'your dog'. Thus human and companion animal relationship could be assessed using the same measure. A number of items were slightly reworded to take account of the limitations of canine-human relationships. In addition, a not relevant category was added to allow respondents to indicate that the item has no relevance to their relationship with their dog. Copies of the QRI used for human and canine companions are shown in Appendix P.

9.2.4.3 Companion demographics

Subjects also gave demographic information on the specified person and dog who they answered the QRI about. For human companions, sex of companion, type of relationship with person (friend, partner, relative), closeness of relationship and the duration of the relationship were recorded. For canine companions, sex of dog, duration of ownership, breed and closeness of relationship were recorded. Subjects were also asked to provide information on other pets they owned. Closeness was rated on a four point scale from extremely close to neutral. Duration of relationship was rated on a 4 point scale; 0-6 months, 6-12 months, 1-5 years, over 5 years. Subjects were also asked to indicate the number of people who could have been recruited to come with them. This was used to check whether subjects in the alone

conditions had restricted social networks compared to subjects tested in other conditions. A copy of this questionnaire can be seen in Appendix Q.

9.2.4.4 Post experimental questionnaire

After the experiment, subjects were given a questionnaire asking about their views on the experimental setting, their ability to concentrate on tasks, their opinion of the experimenter, and evaluation and support during the experiment. All questions were bi-polar and rated on a six point scale. A copy of the questionnaire can be seen in Appendix R.

The experimental setting was rated on pleasantness, relaxation, seriousness and formality. Subjects were also asked to rate their ability to concentrate on each of the tasks to check for any differential distraction effects of presence of companions.

Perception of the experimenter was rated on six aspects, intimidation, nervousness, talkativeness, friendliness, likeability and ability to relax the subject. Talkativeness was included to check for any social catalysis type effects which might be increased with either a human or canine companion as opposed to subjects tested alone. Support-type feelings were assessed using an adaptation of two items used by Kamarck *et al.* (1995). These items assessed how '*helped and supported*' and how '*isolated and alone*' subjects felt during the experiment. Subjects were asked to rate their feelings of being evaluated to enable a comparison of companion conditions. As steps had been taken to make the human companion as non-evaluative as possible, this was used to check this control. Subjects were also asked to rate how '*happy and confident*' they felt about their ability to perform well in the experiment.

Subjects with companions were asked to rate their views towards having the companion with them. Specifically they were asked to rate how happy they felt with their companion's presence, whether they felt any safety from the presence of the

companion and to what extent their concern for their companion affected their ability to relax. Subjects in the dog condition were additionally asked to rate their dog's behaviour on a 1 to 5 scale for how settled they were. Independently, the experimenter also rated the dog's behaviour on the same scale. These two measures agreed substantially, $r=.79$ ($n=17$), $p<.01$.

9.2.4.5 Task Affect Checklist

Subjects were given an adjective checklist to examine attributes of each of the two tasks. Tasks were rated on a 6 point scale from 0 = '*not at all*' to 5 = '*very much*' for how they made the subject feel. Affects considered were: relaxed, stressed, embarrassed, angry, confident, skilful, annoyed, frustrated, successful and frightened. A copy of the scale can be seen in Appendix S.

9.2.4.5.1 Rehearsal Questionnaire

It has been proposed that negative thoughts in the immediate aftermath of a stressor will prolong return of stress indices to baseline levels (Cameron & Meichenbaum, 1982; Haynes *et al.*, 1991; Linden *et al.*, 1997; Roger & Najarian, 1997). Empirical support for this suggestion has come from work by Roger and colleagues who found that, what they term ruminative tendencies, are linked to delayed return of heart rate to baseline after a laboratory stressor (Roger & Jamieson, 1988) and cortisol levels following exposure to a real life stressor (Roger, 1988). However it has been proposed that distraction in the period following a stressor would be able to reduce rumination and so promote quicker recovery (Linden *et al.*, 1997). If the presence of a companion provides a distraction for the subject during the recovery phase of the experiment and thus promotes a quicker return to baseline levels, this would be evidenced by group differences in recovery. A measure of ruminative tendencies would provide a useful co-variate in analyses.

In both of his studies, Roger measured ruminative tendencies using the rehearsal subscale of the Emotional Control Questionnaire (ECQ) (Roger & Najarian, 1989; Roger & Nesshoever, 1987). Although the same subscale was used in this study, after piloting, it was decided to reduce the 14 item scale of Roger and Najarian to 11 items, as it had been demonstrated that three of the items did not load significantly on a rehearsal type factor. The 14 item scale of Roger and Najarian had an internal consistency of 0.86 (estimated by Kuder-Richardson KR20 Formula). In this study, the 11 item scale had an internal consistency of 0.80 (estimated by Kuder-Richardson KR20 Formula).

9.2.4.6 Pre-experimental behaviour questionnaire

At the end of the experimental session, subjects were asked to provide details on pre-experimental behaviour, and personal characteristics which might affect cardiovascular activity. This was the same questionnaire used in experiments 2 and 3 and is shown in Appendix I. Age and sex of subject, weight and height for calculation of body mass index and details of smoking status, prior stress, family history of hypertension and relevant aspects of pre-experimental behaviour were recorded.

9.2.5 Procedure

Subjects and companions were met in the experimental room. Human companions were seated about two meters away from the subject. Human companions were instructed that their role was to support the subject in the experiment and that they could smile or nod to convey this support. They were asked not to speak to, stare at, or touch the subject. The companion could not see the subject's task performance, although the companion and subject could see each other at all times. Companions generally sat and read or watched silently during the experiment. Canine companions were tethered about two meters away from their owners to prevent any physical contact during the experiment. Drinking water was available for dogs during the experiment. Subjects and their dogs could see each other at all times. The experimenter

sat about two meters away from the subject on the other side to the companion and was able to see the subject's performance on the tasks. Given the concerns regarding testing with animals and on members of the public, the experiment was submitted to and received ethical approval from the University of Warwick Psychology Ethics Committee.

Informed consent was obtained from the subjects. The blood pressure monitor was then placed around the subject's upper non-dominant arm. Monitoring took place at two minute intervals throughout the measurement phase of the experiment. Subjects were asked not to talk and to make as few movements as possible with their non-dominant arm during the measurement phase of the experiment. Subjects and if present, their human friend were reminded that they could stop the experiment at any time for whatever reason by indicating to the experimenter.

A diagram of the procedure is given in Figure 9.1. Subjects sat for an initial rest period during which seven measurements were taken. This allowed 8 minutes of acclimatisation time and baseline measurements were taken 8:00, 10:00 and 12:00 minutes into the rest period. Tasks were presented in a fixed order for all subjects. After brief instructions, subjects were given 6:30 minutes in which to attempt the mirror tracing task. Measurements were taken 0:30, 2:30 and 4:30 minutes into the task. A ten minute inter-task rest period then followed, with measurements taken 0:00, 2:00, 4:00, 6:00 8:00 after task off-set. Subjects were then given brief instructions regarding the computer game task which also lasted for 6:30 minutes. Measurements were again taken 0:30, 2:30 and 4:30 minutes into the task. Subjects were then asked to sit for a ten minute final rest period after which they were told measurements would be terminated. Measurements in this period were again at 0:00, 2:00, 4:00, 6:00 8:00 after task off-set.

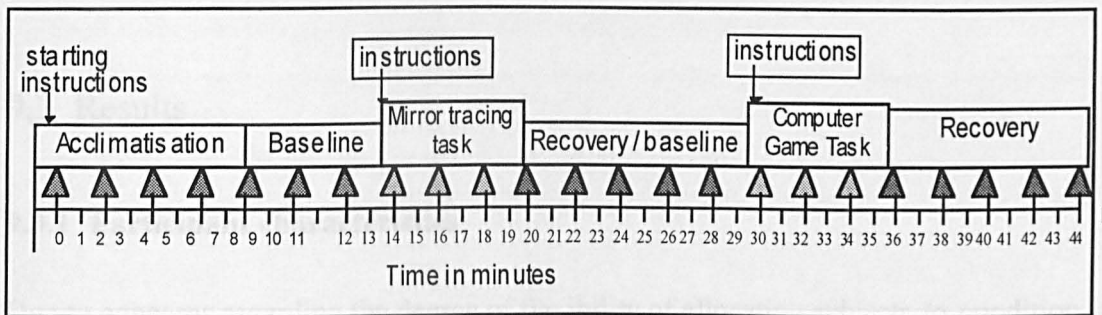


Figure 9.1 Diagram of procedure in experiment four.

At the end of the measurement phase of the experiment, the blood pressure cuff was removed and subjects were asked to fill in the post-experimental questionnaire, task checklist and pre-experimental behaviour questionnaire. Refreshments were offered to all participants and debriefing occurred. Total testing time was approximately one hour per subject.

9.3 Results

9.3.1 Participant characteristics

Due to concerns regarding the degree of flexibility of allocating subjects to condition, a larger number of criteria than in previous experiments were examined to ensure that equivalent subjects had been tested in each condition: Analyses of variance and chi-square tests were used as appropriate. All quantitative variables for which parametric tests were run met assumptions of normality and homogeneity of variance. An alpha level of .05 was set for all statistical tests. Means and standard deviations or distributions are shown in Table 9.2.

Conditions did not vary significantly in distribution of males and females, age of subjects or their self-reported prior stress levels. Proportionally more subjects in the friend condition came from the pet store recruitment site than in the other conditions. This was because subjects were recruited at a slower rate in the friend condition as compared to the other two conditions and recruiting from the pet store was used primarily in the later stages of the study. However the differences in distributions was non-significant. UCLA loneliness scores were equivalent across conditions. Subjects were asked to name how many other people they could have asked to come along with them in addition to the nominated person. The mean score for this item was 4.6 and ranged from 0 to 16 people, ($SD=3.3$). It did not differ significantly between the conditions demonstrating that the experimental groups did not differ in the size of relevant parts of their social networks.

Table 9.2 Group variations in salient demographic variables.

Variable	Control <i>n</i> =22	Friend <i>n</i> =22	Dog <i>n</i> =23	Analysis
dichotomy ratio				
Sex. (male: female)	7:15	7:15	7:16	$\chi^2(2, N=67) = 0.01$, $\phi = .01$, $p = .99$
Origin of subjects (Dog Club: Pet Store)	17:5	12:10	17:6	$\chi^2(2, N=67) = 3.09$, $\phi = .21$, $p = .21$
Regular smoker (yes: no)	3:19	7:14 ^a	7:16	$\chi^2(2, N=66) = 2.58$, $\phi = .20$, $p = .27$
means (standard deviations)				
Age (years)	42.5 (11.1)	38.3 (13.1)	42.0 (14.5)	$F(2,64) = 0.70$, $r^2 = .02$, $p = .50$
Prior stress (1= intense, 2= a lot, 3= tolerable, 4= very little, 5= none)	2.9 (0.8)	2.6 ^b (0.8)	3.0 (1.1)	$F(2,63) = 1.05$, $r^2 = .03$, $p = .36$
UCLA loneliness scale ^c (higher score = more lonely)	35.2 (8.8)	37.5 (8.8)	32.0 (8.4)	$F(2,55) = 1.99$, $r^2 = .07$, $p = .15$
Other friends to bring ^d	3.8 (2.9)	4.9 (3.8)	4.9 (3.2)	$F(2,55) = 0.77$, $r^2 = .03$, $p = .47$
Rehearsal score ^e (higher score = greater tendency to ruminate)	3.6 (3.0)	4.8 (2.7)	3.6 (2.5)	$F(2,61) = 1.25$, $r^2 = .04$, $p = .30$
Baseline systolic blood pressure (mmHg)	122.0 (12.6)	121.7 (12.0)	119.5 (12.8)	$F(2,64) = 0.15$, $r^2 < .01$, $p = .86$
Baseline diastolic blood pressure (mmHg)	68.1 (10.8)	67.8 (7.1)	72.0 (12.3)	$F(2,64) = 1.18$, $r^2 = .04$, $p = .31$
Baseline heart rate (bpm)	69.0 (11.2)	68.2 (9.6)	75.3 (9.6)	$F(2,64) = 3.39$, $r^2 = .10$, $p = .04$

Note. a= missing data on smoking status for 1 subject.

b= missing data on prior stress scale for 1 subject.

c= missing UCLA loneliness score for 9 subjects, 3:3:3 for alone, friend and dog conditions respectively.

d= missing data on 'how many other friend could bring' for 4 subjects, 3:0:1 for alone, friend and dog conditions respectively.

e= missing data on rehearsal score for 3 subjects, in 0:2:1 for alone, friend and dog conditions respectively.

Adherence to pre-experimental controls on previous exercise, smoking, eating, caffeine and alcohol use prior to the experiment was fairly good. Non-adherence was infrequent and evenly spread between groups, see Table 9.3.

Table 9.3 Adherence to pre-experimental controls

Restriction time frame	Able to adhere (yes : no)			Analysis
	Control <i>n</i> =22	Friend <i>n</i> =21 ^a	Dog <i>n</i> =23	
Eating < 2 hours	17:5	14:7	17:6	$\chi^2(2, N=66) = 0.63$, $\phi = .10$, $p = .73$
Caffeine < 3 hours	18:4	18:3	21:2	$\chi^2(2, N=66) = 0.01$, $\phi = .11$, $p = .99$
Smoking < 3 hours	20:2	18:3	21:2	$\chi^2(2, N=66) = 0.44$, $\phi = .08$, $p = .80$
Strenuous exercise < 3 hours	19:3	20:1	21:2	$\chi^2(2, N=66) = 1.03$, $\phi = .13$, $p = .60$
Alcohol < 12 hours	22:0	19:2	22:1	$\chi^2(2, N=66) = 2.25$, $\phi = .18$, $p = .32$

Note. a= Missing data for one subject in the friend condition on all pre-experimental control variables.

9.3.2 Comparison of companion characteristics

Although no subject was required to bring both a dog and a friend with them, people were asked to fill in assessments regarding the companion accompanying them and the one(s) they would have been most likely to bring had they been in the relevant condition. These assessments were then checked to see that, excluding convenience and behavioural reasons, each subject could potentially have brought similar types of companion.

All human companions met the criterion of having been a friend for longer than 6 months. Most subjects, (50/59) had known their nominated person for longer than 5 years. Despite the selection criteria of subjects needing to own dogs for longer than 6

months, two subjects subsequently reported having owned their dog for less than 6 months. There was no significant difference in the closeness rating people gave to their human and canine relationships $F(1,57) = 0.23, p = .64$. No subject rated the closeness of either their human or canine relationship 'neutral'.

Human-human relationship subscale scores were derived as per instructions of Pierce *et al.* (1991). This meant that scores for each scale were standardised with a minimum of 1 and maximum of 4. Cronbach's alpha's were calculated from the total number of complete sets of data for each scale. Internal consistency for the support scale was somewhat lower than Pierce *et al.*, although conflict and depth subscales had similar internal consistency, see Table 9.4.

Table 9.4 Comparison of Cronbach alpha's for QRI friend subscales, Pierce *et al.* (1991) and the current study.

Study	QRI Subscale alphas		
	support (7 items)	conflict (12 items)	depth (6 items)
Pierce <i>et al.</i> (1997) friend scores	.85	.91	.84
Current study friend scales	(<i>n</i> =60) .78	(<i>n</i> =52) .89	(<i>n</i> =57) .85
Current study dog scales	(<i>n</i> =38) .85	11 items (<i>n</i> =43) .88	(<i>n</i> =56) .86

At the design stage, it was decided to allow subjects to respond 'not relevant' to items for the dog relationships. As expected, some people rated dogs as not able to provide certain more practical types of support (give advice, practical help) or able to have emotional states required for some of the conflict items (criticism, wanting owner to change) and marked the question 'not relevant'. Table 9.5 provides a summary of items regarded as of low relevance by respondents i.e. more than 10% of sample considered it not relevant.

Table 9.5 Frequency of low relevance items, DOG QRI

Item	Type	Percentage of sample with each response				
		Not relevant	Not at all	A little	Quite a bit	Very much
extent you could turn to x for advice with problems	support	62	13	10	10	5
count on x for practical help with a problem	support	52	18	17	8	5
count on x to be honest and genuine with you	support	17	5	5	12	62
count on x to help you if family member very close to you died	support	13	7	15	23	42
count on x to listen to you when you are very angry at someone else	support	25	12	10	10	43
how critical of you is x	conflict	43	38	15	3	0
how much do you think x wants you to change	conflict	22	47	20	8	3

Note. In the dog QRI, 'x' was replaced by 'your dog', the friend QRI was identical except 'x' was replaced by 'your friend'.

A usual tactic with a lot of missing data on specific items is to discard those items from the scale to ensure a higher number of complete data sets. However, in this study the data was not missing but rather the question was regarded as not relevant. On the support scale, the two items in the support scale regarded as not relevant by >50% of sample, when marked as not relevant were recoded to '*not at all*'. On such a short scale, removing these items and then taking an average of the remaining item scores could have over-inflated the dog's score, when in fact really dogs do not offer some types of support in most people's eyes and should therefore score low. The other items which were considered as irrelevant by much fewer respondents (25%) were not recoded in this manner, because the answers of those who did respond tended to indicate that dogs could provide assistance. This however resulted in a high number of missing scores. The resultant seven item support scale had an internal consistency of

Cronbach's alpha = .85 ($n=38$).

One of the conflict items was marked as not-relevant by 43% of subjects and so was excluded from the scale. It was not possible to assume that this type of answer could reflect no criticism and so low conflict. The resulting 11 item conflict scale had a Cronbach's alpha = .88 ($n=43$). The depth scale items were answered by the majority of subjects and had a Cronbach's alpha of 0.86 ($n=56$).

QRI subscale scores for both human and canine relationship, and closeness and duration of relationship ratings are given in Table 9.6.

People tested in the different experimental groups did not differ in the ratings they gave for closeness and duration of their human or canine relationships. Human QRI subscales scores also did not differ across groups. Unfortunately, even with the attempts to preserve as many scale scores for the dog QRI support and conflict scales, there is missing data for many respondents. This makes using these scores to determine if there are relationship differences across conditions dubious. On the available scores, however, there does not appear to be any suggestion that the type of dog which would have been brought or was actually brought differed between conditions. This suggests that excepting structural constraints regarding bringing friends and dogs with them, that all subjects could have potentially recruited equivalently close companions.

Loneliness scores related significantly and in the expected direction to other human social variables. Those who rated their human relationship as extremely close had a significantly lower loneliness score than those rating their human relationship as less close $F(1,49) = 6.03, p=.02$. Loneliness score was also significantly related to human QRI scores with those more lonely rating their nominated human relationship as less supportive $r=-.33, n=52, p=.02$, having more conflict, $r=.33, n=46, p=.02$ and tending to have less depth $r=-0.23, n=51, p=.11$.

Table 9.6 Comparison of human and canine companion relationship characteristics

Variable	valid n	Missing data	Control n=22	Friend n=22	Dog n=23	Analysis
Friend closeness (1=extremely close, 2=close, 3=OK, 4=neutral)	59	5:1:2	1.3 (0.5)	1.4 (0.6)	1.3 (0.6)	$F(2,56) = 0.12$, $r^2 < .01$, $p = .89$
Friend time known (1=0-6mths, 2=6mths-1yr, 3=1-5yrs, 4=>5yrs)	59	5:1:2	4 (0)	4 (0)	4 (0)	$H(2, N=59) =$ 0.04 , $p = .98$
Friend QRI support	60	4:1:2	3.6 (0.3)	3.4 (0.5)	3.6 (0.4)	$F(2,57) = 1.65$, $r^2 = .06$, $p = .20$
Friend QRI conflict	52	5:4:6	1.6 (0.4)	1.7 (0.5)	1.7 (0.4)	$F(2,49) = 0.25$, $r^2 = .01$, $p = .78$
Friend QRI depth	57	5:2:3	3.6 (0.4)	3.5 (0.5)	3.6 (0.5)	$F(2,54) = 0.34$, $r^2 = .01$, $p = .72$
Dog closeness (1=extremely close, 2=close, 3=OK, 4=neutral)	65	1:1:0	1 (0)	1 (1)	1 (1)	$H(2, N=65)$ $= 1.45$, $p = .49$
Dog time owned (1=0-6mths, 2=6mths-1yr, 3=1-5yrs, 4=>5yrs)	66	0:1:0	3.2 (0.9)	3.0 (0.6)	2.8 (0.6)	$F(2,63) = 1.30$, $r^2 = .04$, $p = .28$
Dog QRI support	42	8:7:13	2.7 (0.6)	3.1 (0.8)	2.9 (0.7)	$F(2,39) = 1.19$, $r^2 = .06$, $p = .32$
Dog QRI conflict	44	7:4:12	1.9 (0.7)	1.7 (0.5)	1.8 (0.4)	$F(2,41) = 0.56$, $r^2 = .03$, $p = .58$
Dog QRI depth	60	2:1:4	3.4 (0.5)	3.5 (0.6)	3.6 (0.5)	$F(2,57) = 0.88$, $r^2 = .03$, $p = .42$

Note. Group means with standard deviations in parentheses are shown.

Due to the varying missing data for each measure, this is shown in the ratio for each group, alone, friend and dog respectively.

The relationship between the friend QRI subscales and the UCLA loneliness score was similar to that found by Pierce *et al.* (1991). There was no relationship between loneliness score and any dog relationship score (lowest $p = .29$) suggesting that the relationship between loneliness and less positive human relationship assessment was not just a result of a global more negative response style. Loneliness also correlated negatively with the measure of social network size as indexed by the number of human companions the subject mentioned they would be able to bring along $r = -.32$, $n = 54$

$p=.02$, more lonely people mentioned fewer other potential human companions.

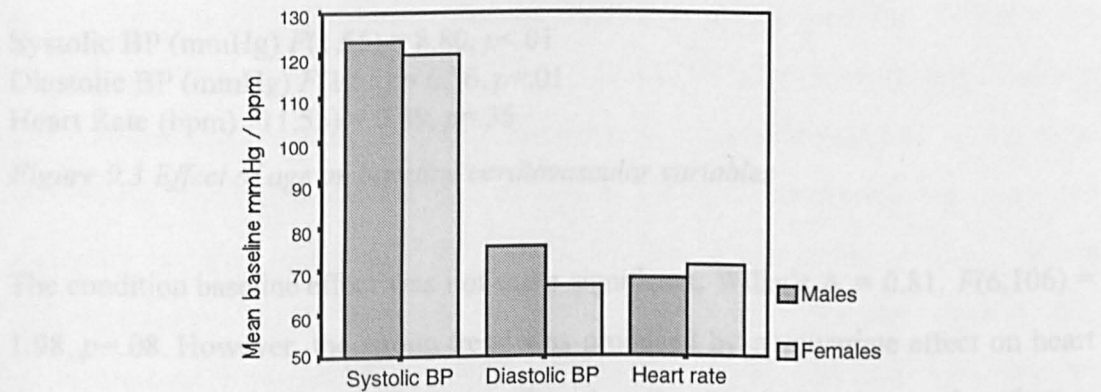
9.3.3 Physiological baseline data

Baseline levels were taken as the average of three measurements over the final five minutes of the initial rest period. This allowed subjects 8 minutes in which to adapt to the experimental setting and measurement procedure prior to baseline determination. A second baseline was taken as the average of the final three measurements in the inter-task period. This allowed subjects four minutes in which to recover after the first task before the second baseline was determined. Task levels were estimated from the average of the three measurements taken during each task.

Due to the significant baseline differences in heart rate as shown in Table 9.2, an initial MANOVA was conducted on baseline levels of systolic BP, diastolic BP and heart rate with between-subjects factors of SEX, AGE (young, <40 years; old ≥ 40 years) and GROUP (alone, friend, dog) and a within-subjects factor of BASELINE (initial, inter-task). A full summary table for the MANOVA is shown in Appendix T. Due to further concerns raised by this analysis, see section 9.3.3.1, it was decided to analyse reactivity at a univariate level which allowed baseline levels to be added as a co-variate where necessary. Separate univariate analyses of variance were conducted on reactivity to each of the tasks as, first, the aim of the experiment was not to compare differences between the two tasks and second, as the task order was invariant it would have been impossible to distinguish between order effects and task differences in this design. Summaries of these univariate analyses are given in each section. In each analysis, younger and female subjects were expected to show lower blood pressure but higher heart rate levels. It was hypothesised that the reactivity for friend and dog groups would be lower than for the group tested alone (only experimenter present). No prediction was made for the difference in reactivity for friend and dog groups.

9.3.3.1 Effects of sex, age and experimental group on baseline levels

As expected from population studies, baseline levels were significantly different for males and females, Wilks's $\Lambda = 0.67$, $F(3,53) = 8.88$, $p < .01$. Univariate tests revealed males as having significantly higher diastolic blood pressure levels than females, as shown in Figure 9.2.



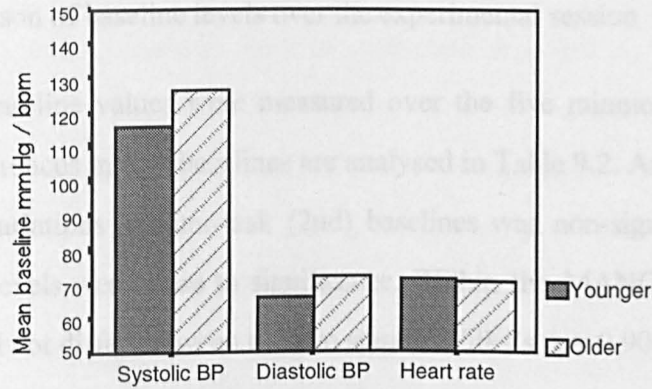
Systolic BP (mmHg) $F(1,55) = 0.77$, $p = .38$

Diastolic BP (mmHg) $F(1,55) = 14.51$, $p < .01$

Heart Rate (bpm) $F(1,55) = 2.64$, $p = .11$

Figure 9.2 The effect of subject's sex on baseline cardiovascular variables.

There was also a difference between the two age groups Wilks's $\Lambda = 0.82$, $F(3,53) = 3.93$, $p = .01$. Univariate analyses showed that this effect was significant for both systolic and diastolic blood pressure, with older subjects having higher blood pressure levels than younger subjects, as shown in Figure 9.3.



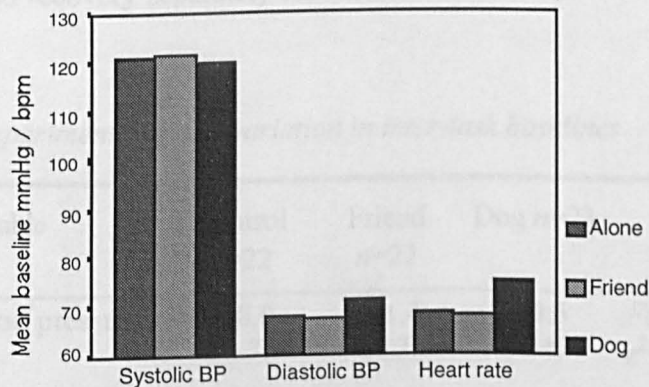
Systolic BP (mmHg) $F(1,55) = 8.80, p < .01$

Diastolic BP (mmHg) $F(1,55) = 6.56, p = .01$

Heart Rate (bpm) $F(1,55) = 0.89, p = .35$

Figure 9.3 Effect of age on baseline cardiovascular variables

The condition baseline effect was not quite significant, Wilks's $\Lambda = 0.81, F(6,106) = 1.98, p = .08$. However, the strong trend was produced by a univariate effect on heart rate which was higher for the dog group than the other two groups even when factors of age and sex were taken into account. Due to this discrepancy between groups, it was decided to analyse reactivity at a univariate level which allowed baseline heart rate to be added as a co-variate to the analysis of heart rate reactivity.



Systolic BP (mmHg) $F(2,55) = 0.04, p = .96$

Diastolic BP (mmHg) $F(2,55) = 1.17, p = .32$

Heart Rate (bpm) $F(2,55) = 4.22, p = .02$

Figure 9.4 Differences between experimental groups on baseline cardiovascular variables

9.3.3.2 Comparison of baseline levels over the experimental session

Cardiovascular baseline values were measured over the five minutes preceding each task. Group differences in first baselines are analysed in Table 9.2. As shown in Table 9.7, the group variations in inter-task (2nd) baselines was non-significant, although again heart rate levels were close to significance. Within the MANOVA on baseline levels, values did not differ between the two stages, Wilks's $\Lambda = 0.90$, $F(3,53) = 1.89$, $p = .14$. Importantly, the change between the two stages was not different by condition, Wilks's $\Lambda = 0.90$, $F(6,106) = 1.00$, $p = .42$. If subjects in the dog condition were already slightly aroused prior to the first task, whereas the subjects in the alone and friend conditions were not, then this might have moderated the measured reactivity to the subsequent task. However, the preservation of these group differences even after 30 minutes of the experiment, mitigates against this interpretation. It suggests that the difference in first baselines was due to physiological differences in basal levels.

Although the differences in values at the two stages were not great, on average for blood pressure less than one mmHg between the two stages and for heart rate less than one bpm, it was decided to use immediately preceding values for determination of reactivity and recovery separately for each task.

Table 9.7 Experimental group variation in inter-task baselines

Variable	Control <i>n</i> =22	Friend <i>n</i> =22	Dog <i>n</i> =23	Analysis
Systolic blood pressure (mmHg)	120.0 (11.7)	121.4 (13.7)	119.5 (12.8)	$F(2,64) = 0.14$, $r^2 < .01$, $p = .87$
Diastolic blood pressure (mmHg)	67.7 (11.0)	67.4 (8.5)	70.3 (11.2)	$F(2,64) = 0.54$, $r^2 = 0.01$, $p = .59$
Heart rate (bpm)	68.0 (11.4)	68.0 (8.9)	74.2 (8.8)	$F(2,64) = 3.07$, $r^2 = .09$, $p = .05$

Note. Group means with standard deviations in parentheses are shown.

9.3.4 Analyses of physiological reactivity

Consistent with previous research, both tasks elicited large changes in cardiovascular activity compared to the immediately preceding baseline. Average reactivity for the mirror tracing task was 11.9 mmHg ($SD=7.5$ SBP, 7.8 mmHg ($SD=5.9$) DBP and 5.7 bpm ($SD=4.9$) HR. Average reactivity for the computer game task was 12.0 mmHg ($SD=8.1$) SBP, 8.9 mmHg ($SD=6.9$) DBP and 4.8 bpm ($SD=5.1$) HR. The magnitude of reactivity to the mirror tracing task is similar to that seen in other studies, taking into account age differences in samples (Gillin *et al.*, 1996; Steptoe, Evans, & Fieldman, 1997). The exact computer game could not be found in any other studies.

9.3.4.1 Mirror tracing task

An Age x Sex x Condition ANOVA was conducted on systolic blood pressure reactivity to the mirror tracing task. There was a significant effect of age, with older subjects having higher reactivity than younger subjects $F(1,55) = 12.56, p < .01$. The sex effect was non-significant $F(1,55) = 2.71, p = .11$. The condition effect was significant $F(2,55) = 4.58, p = .01$, reactivity was highest in the alone condition and lowest in the dog condition, see Figure 9.5. Planned contrasts revealed a tendency for the friend group to have lower reactivity than the alone group $F(1,55) = 3.38, p = .07$, and that the dog group had significantly lower reactivity than the alone group $F(1,55) = 8.96, p < .01$. No higher order interactions between factors were significant.

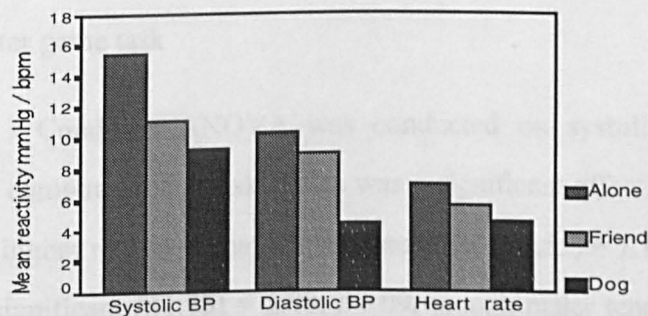


Figure 9.5 Reactivity to the mirror tracing task for the three groups.

An Age x Sex x Condition ANOVA was conducted on diastolic blood pressure reactivity to the mirror tracing task. The age effect was non-significant $F(1,55) = 0.06$, $p=.81$. The sex effect was also non-significant $F(1,55) < 0.01$, $p=.95$. The condition effect was significant $F(2,55) = 4.94$, $p=.01$, reactivity was highest in the alone condition and lowest in the dog condition, see Figure 9.5. Planned contrasts revealed no significant difference in reactivity for alone and friend groups $F(1,55) = 0.37$, $p=.55$, but the dog group had significantly lower reactivity than the alone group $F(1,55) = 8.94$, $p<.01$. None of the higher order interactions was significant.

An Age x Sex x Condition ANOVA was conducted on heart rate reactivity to the mirror tracing task with first baseline heart rate used as a covariate. The age effect was non-significant $F(1,54) = 0.50$, $p=.48$. There was a significant sex difference, $F(1,54) = 6.99$, $p=.01$, with males having higher reactivity to the task than females. The condition effect was non-significant $F(2,54) = 1.97$, $p=.15$. There was an interaction between condition and age $F(2,54) = 3.71$, $p=.03$. To assess this interaction, separate analyses were run on the older and younger subjects. For the younger subjects, there was a significant condition effect, $F(2,27) = 3.76$, $p=.04$. Post hoc tests revealed tendencies for both friend ($p=.08$) and dog ($p=.051$) groups to have lower reactivity than the alone group. For older participants, the condition effect was non-significant $F(2,26) = 1.85$, $p=.18$. There were no other significant higher order interactions between factors.

9.3.4.2 Computer game task

An Age x Sex x Condition ANOVA was conducted on systolic blood pressure reactivity to the computer game task. There was a significant effect of age, with older subjects having higher reactivity than younger subjects $F(1,55) = 7.13$, $p=.01$. The sex effect was non-significant $F(1,55) = 2.98$, $p=.09$, though males tended to have higher reactivity than females. The condition effect was significant $F(2,55) = 7.13$, $p=.01$, reactivity was highest in the alone condition and lowest in the dog condition, see

Figure 9.6. Planned contrasts revealed both friend and dog groups had significantly lower reactivity to the task than the alone group, alone - friend $F(1,55) = 5.18, p = .03$, alone - dog $F(1,55) = 6.99, p = .01$. None of the interactions were significant.

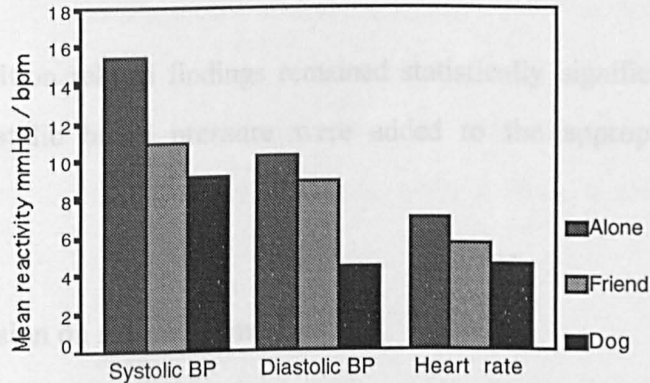


Figure 9.6 Reactivity to the computer game task for the three groups.

An Age x Sex x Condition ANOVA was conducted on diastolic blood pressure reactivity to the computer game task. There was no significant effect of age $F(1,55) < 0.01, p = .95$. The sex effect was also non-significant $F(1,55) = 2.92, p = .09$, though again males tended to have higher reactivity than females. The condition effect was significant $F(2,55) = 4.54, p = .02$, reactivity was highest in the alone condition and lowest in the dog condition, see Figure 9.6. Planned contrasts revealed no significant difference between reactivity of alone and friend groups $F(1,55) = 2.11, p = .15$, but the dog group had significantly lower reactivity than the alone group $F(1,55) = 9.08, p < .01$. None of the higher order interactions was significant.

An Age x Sex x Condition ANOVA was conducted on heart rate reactivity to the computer game task with the immediately preceding heart rate baseline used as a covariate. The age effect was non-significant $F(1,54) = 0.02, p = .88$ as was the sex effect $F(1,54) = 1.07, p = .31$. The condition effect was also non-significant $F(2,54) = 1.50, p = .23$. There was a significant three-way interaction between condition, age and sex, $F(2,54) = 3.88, p = .03$. This was evaluated using separate ANOVAs for older and

younger subjects. Similarly to the mirror tracing task, stronger condition differences were found for younger $F(2,27) = 3.98, p = .03$ than older subjects $F(2,26) = .69, p = .51$. For younger subjects, those in the friend group reacted significantly ($p = .02$) less than the alone group participants, dog group - alone group difference was not significant ($p = .28$). There were no other significant higher order interactions.

All of the condition related findings remained statistically significant when baseline systolic or diastolic blood pressure were added to the appropriate analyses as covariates.

9.3.4.3 Conclusion on reactivity analyses

In summary, significant condition differences emerged for both blood pressure analyses to both tasks. In each case, reactivity in the dog group was significantly lower than that in the alone group. For the friend group there was a non-significant trend to lower systolic reactivity to the mirror tracing task than the alone group and significantly lower reactivity to the computer game task. However, the friend group's diastolic reactivity did not differ significantly from the alone group reactivity to either task.

Condition effects on heart rate were non-significant for both tasks. For the mirror tracing task, there was a two-way age by condition interaction and a significant three way interaction between sex age and condition for the computer game task. These were evaluated using separate ANOVAs for older and younger subjects. In both cases effects were present only for younger subjects. For the mirror tracing task, there were trends for lower reactivity in both the dog and friend groups as compared to the alone group. For the computer game task, the reactivity of the friend group was significantly less than for the alone group.

These results are summarised in Table 9.8 and Table 9.9. Effect sizes are larger for the

effect of the dog in moderating reactivity than for the friend group. The effect of friend in moderating reactivity is of the order of 0.61 for systolic blood pressure, 0.32 for diastolic blood pressure and 0.33 for heart rate, these correspond to medium to large effects on systolic blood pressure and small to medium effects on diastolic blood pressure and heart rate. The effect of the dog moderating reactivity is 0.73 for systolic blood pressure, 0.90 for diastolic blood pressure, and 0.43 for heart rate. These are medium to large effects on systolic blood pressure, large effects on diastolic blood pressure and small to medium effects on heart rate. For the friend moderation, stronger effects were seen for the computer game task whereas stronger effects were seen for the dog moderation on the mirror tracing task.

Table 9.8 Summary of reactivity effects - alone and friend groups

Effect	mean reactivity alone group	mean reactivity friend group	effect size (d)	Planned comparison
SBP mirror	15.48	10.98	0.57	$F(1,55) = 3.38, p=.07$
SBP game	15.88	9.80	0.71	$F(1,55) = 5.18, p=.03$
DBP mirror	10.30	9.00	0.21	$F(1,55) = 0.37, p=.55$
DBP game	11.80	8.67	0.43	$F(1,55) = 2.11, p=.15$
HR mirror	6.98	5.65	0.28	not conducted as main
HR game	6.08	4.20	0.37	effect non-significant

Table 9.9 Summary of reactivity effects - alone and dog groups

Effect	mean reactivity alone group	mean reactivity friend group	effect size (d)	Planned comparison
SBP mirror	15.48	9.28	0.81	$F(1,55) = 8.96, p<.01$
SBP game	15.88	10.52	0.65	$F(1,55) = 6.99, p=.01$
DBP mirror	10.30	4.39	1.06	$F(1,55) = 8.94, p<.01$
DBP game	11.80	6.32	0.74	$F(1,55) = 9.08, p=.01$
HR mirror	6.98	4.55	0.46	not conducted as main
HR game	6.08	4.03	0.39	effect non-significant

9.3.5 Analysis of recovery data

In contrast to reactivity analysis, there is no convention for analysis of recovery data. A number of alternatives exist (Haynes *et al.*, 1991; Linden *et al.*, 1997): 1) analysis of area under a recovery curve, 2) latency to recovery (time taken to achieve pre-stressor levels, 3) absolute levels post-stressor, 4) absolute change scores relative to baseline or task levels 5) percentage change scores; and 6) absolute change scores relative to baseline or task levels, with covariates.

Cardiovascular recovery measures were taken at two minute intervals after task offset. This time interval was imposed by constraints due to the measurement technique and equipment. A shorter interval would be likely to lead to venous pooling which could inflate measurements and cause discomfort to the subject. However, the relatively lengthy time interval meant that there are not enough data points to allow meaningful examination of a recovery curve or to assess time to return to baseline (Linden *et al.*, 1997). Therefore neither option 1 nor option 2 was viable.

Option 3, taking absolute levels, is a strategy frequently used (Linden *et al.*, 1997) but was rejected in this study. Absolute values reflect to a large extent differences which exist at baseline. Therefore, option 4, examining change scores either relative to the baseline or task levels is considered a more meaningful method of analysis (Hocking Schuler & O'Brien, 1997; Linden *et al.*, 1997): However, no recommendation is made for one method over the other.

Linden *et al.* (1997) suggests that, as change scores from either baseline or task level are highly influenced by reactivity, percentage analysis would be warranted. Pilot analysis determined that examining percentage change scores is not viable as it produces a number of wide outliers due to small absolute reactivities and is difficult to interpret if reactivity is negative. Therefore option 5 was rejected.

As an alternative, to percentage scores, reactivity or baseline measures can be used as a co-variate in analysis (option 6). This is a frequently used strategy in reactivity analyses. The advantage of this is that it controls for differences in either reactivity or baseline levels. Both change relative to task level, and change relative to baseline levels, are likely to be highly dependent on baseline and reactivity levels (Haynes *et al.*, 1991). As the previous reactivity analyses had established clear reactivity differences between groups, and the baseline levels especially for heart rate were uneven between groups, it seemed that inclusion of a co-variate to the analysis of change scores was a sensible precaution.

In summary, due to the lack of consensus as to best practice for analysis of recovery data (Linden *et al.*, 1997), two separate analyses were carried out. First, recovery was analysed as change scores from baseline, with reactivity added as a co-variate. This has the advantage of partialling out the pre-existing differences in reactivity. Second, recovery was analysed as change from baseline, with baseline added as a co-variate. Between subjects factors of SEX, AGE (younger, <40 years; older ≥ 40 years) and GROUP (alone, friend, dog) were used.

A recovery measure was calculated as the average of the three measurements immediately following task off-set covering a period of 5 minutes. Although this time interval is short, examination of recovery profiles suggests that all cardiovascular variables were close to baseline by this stage. Statistical analyses confirmed this as the values of cardiovascular levels at and after this point either did not differ significantly from baseline or were below baseline levels¹². This finding of a swift return to baseline has been noted by other researchers (Linden *et al.*, 1997) and suggests that monitoring recovery after such a point has no value and may be confounded by increases due to other intervening factors such as anticipation of following events or boredom.

¹²Evaluated using the 'constant' term in a MANOVA but only looking at univariate tests to see if levels at each stage differ from baseline i.e. zero as they are change scores.

Subjects were given the rehearsal scale of the ECQ (Roger & Najarian, 1989) to assess trait tendencies to ruminate on stressors. Rehearsal tendencies did not differ by experimental group, see Table 9.2. It had been proposed that rehearsal tendencies would be related to recovery indices, with subjects with higher rehearsal scores having more prolonged recovery. To assess this relationship, rehearsal scores were correlated with the recovery measure, see Table 9.10. Although none of the rehearsal correlations were significant, it is important to note that the majority are in the opposite direction to that expected i.e. in this study those with worse (higher) recovery had lower rehearsal tendencies. An AGE x SEX x GROUP ANOVA was conducted on rehearsal scores. None of the main effects or interactions were significant. Due to this non relationship of rehearsal with any other factors, the following analyses were all initially conducted without rehearsal as a covariate.

Table 9.10 Relationship between rehearsal scale and recovery indices

Recovery		Rehearsal N=64	Performance N=67 mirror N=60 computer
Mirror Tracing	SBP	-0.07	-0.14
	DBP	-0.12	-0.02
	HR	-0.23	0.22
Computer Game	SBP	-0.20	0.20
	DBP	0.09	0.13
	HR	-0.20	0.15

Note. No score had $p < .05$.

9.3.5.1 Recovery from mirror tracing with reactivity as a co-variate

Three separate Age x Sex x Condition ANOVAs were conducted on recovery from the mirror tracing task, using the relevant reactivity as a covariate. Results were similar for all variables as shown in Table 9.11. None of the main effects or higher order interactions were significant for any analysis. There was a slight non-significant trend for females to have quicker diastolic reactivity than males.

Table 9.11 Main effects of age, sex and condition on recovery from the mirror tracing task, using reactivity as a co-variate.

	Age	Sex	Condition
SBP	$F(1,54) = 0.71, p=.40$	$F(1,54) = 1.07, p=.31$	$F(2,54) = 0.64, p=.53$
DBP	$F(1,54) = 1.75, p=.19$	$F(1,54) = 3.98, p=.052$	$F(2,54) = 0.24, p=.78$
HR	$F(1,54) = 0.02, p=.90$	$F(1,54) = 0.56, p=.46$	$F(2,54) = 0.27, p=.76$

The reactivity covariates in the above analyses made a significant contribution to both blood pressure models $F(1,54) = 18.58, p<.01$ for systolic blood pressure and $F(1,54) = 7.30, p<.01$, however, the contribution to the heart rate model was non-significant $F(1,54) = 1.79, p=.19$. The addition of rumination as a second co-variate into the analysis did not affect the significance of any of the effects and it did not contribute significantly to any of the models.

9.3.5.2 Recovery from computer game with reactivity as a co-variate

Non-significant results were also found for recovery to the computer game task analysed in Age x Sex x Condition ANOVAs with the relevant reactivity as a covariate. As shown in Table 9.12, none of the main effects or higher order interactions were significant for any analysis.

Table 9.12 Main effects of age, sex and condition on recovery from the computer game task, using reactivity as a co-variate.

	Age	Sex	Condition
SBP	$F(1,54) = 0.39, p=.53$	$F(1,54) = 0.04, p=.83$	$F(2,54) = 1.28, p=.29$
DBP	$F(1,54) = 0.42, p=.52$	$F(1,54) = 0.38, p=.54$	$F(2,54) = 0.11, p=.89$
HR	$F(1,54) < 0.01, p=.99$	$F(1,54) = 0.59, p=.45$	$F(2,54) = 2.63, p=.08$

The reactivity covariates in the above analyses made a significant contribution to both blood pressure models, $F(1,54) = 7.18, p<.01$ for systolic blood pressure and $F(1,54)$

15.09, $p<.01$, and heart rate model $F(1,54) = 10.22, p<.01$. The addition of rumination as a second co-variate into the analysis did not affect the significance of any of the effects and was not a significant predictor in any of the models.

It is arguable that inclusion of the reactivity covariate removed so much of the variance in recovery measures that this swamped any group differences which might exist. Therefore, baseline levels were used as covariates in a second set of analyses.

9.3.5.3 Recovery from mirror tracing with baseline as a co-variate

Results of the Age x Sex x Condition ANOVAs on recovery from the mirror tracing task with the appropriate baseline used as a covariate are shown in Table 9.13.

Table 9.13 Main effects of age, sex and condition on recovery from the mirror tracing task, using baseline as a co-variate.

	Age	Sex	Condition
SBP	$F(1,54) 0.24, p=.63$	$F(1,54) = 2.66, p=.11$	$F(2,54) = 2.18, p=.12$
DBP	$F(1,54) = 0.58, p=.45$	$F(1,54) = 5.16, p=.03$	$F(2,54) = 0.93, p=.40$
HR	$F(1,54) < 0.01, p=.94$	$F(1,54) = 0.98, p=.33$	$F(2,54) = 0.32, p=.73$

Similarly to the analysis using reactivity as the co-variate, in the analysis of diastolic blood pressure recovery with baseline as a co-variate, females had quicker recovery than males. However, no other main effects or interactions were significant.

The baseline covariates in the above analyses were not significant predictors for any of the models. The addition of rumination as a second co-variate into the analysis did not affect the significance of any of the effects and it did not contribute significantly to any of the models.

9.3.5.4 Recovery from computer game with baseline as a co-variate

Results of the Age x Sex x Condition ANOVAs on recovery from the computer game task with the appropriate baseline used as a covariate are shown in Table 9.14.

Table 9.14 Main effects of age, sex and condition on recovery from the computer game task, using baseline as a co-variate.

	Age	Sex	Condition
SBP	$F(1,54) 0.01, p=.90$	$F(1,54) = 0.54, p=.47$	$F(2,54) = 3.24, p=.05$
DBP	$F(1,54) = 0.03, p=.87$	$F(1,54) = 0.87, p=.36$	$F(2,54) = 0.70, p=.50$
HR	$F(1,54) 0.04, p=.85$	$F(1,54) = 0.82, p=.37$	$F(2,54) = 2.15, p=.13$

For systolic blood pressure recovery from the computer game task with systolic blood pressure baseline used as a covariate, the condition effect was significant, with the friend group having the quickest recovery and the alone group the slowest. Condition differences were explored using Tukey tests. No pairwise comparisons reached significance, however, there was a tendency for the friend group to recover more quickly than the alone group ($p=.07$), the alone to dog group comparison did not reach significance ($p=.11$). There were no other significant main effects or higher order interactions between the factors on any of the analyses.

The baseline covariates in the above analyses were not significant predictors for any of the models. The addition of rumination as a second co-variate into the analysis in the systolic analysis was just non-significant $F(2,50) 2.97, p=.06$ but did not affect the significance of any of the other effects. Rumination did not contribute significantly to the diastolic or heart rate models.

9.3.5.5 Conclusions from the recovery analyses

In summary, in only one analysis, was there a significant effects of condition on recovery. There was a trend for friend groups to have slightly swifter systolic blood

pressure recovery to the computer game task than the alone group when baseline was used as a co-variate, although the main effect was non-significant when reactivity was used as a co-variate. Females had swifter diastolic blood pressure recovery to the mirror tracing task using both analysis techniques. Rehearsal tendencies had no effect on the analysis. There seemed to be no differences in analysing the recovery data with either reactivity or baseline as a co-variate, except reactivity made a significant contribution to the majority of analyses.

9.3.6 Task data

9.3.6.1 Task performance

Task performance was assessed to determine whether the presence of a companion might have distracted the subjects from their task and so affected reactivity in this manner. Task performance in the mirror tracing task was assessed by the number of complete star circuits traced and on the computer game by number of targets hit before 10 misses. Performance of the two tasks was not significantly related $r=.24$, $n=67$, $p=.06$, although subjects performing well on one task tended to perform well on the other. During the course of the data collection it was noted that older subjects and especially older females reported less ability at using computers. Therefore in the analysis of performance, both age and sex were included as factors. To assess performance, a three way ANOVA, with factors of GROUP (alone, friend, dog), AGE (younger, <40 years; older ≥ 40 years) x SEX was conducted. Performance was analysed separately for the two tasks.

For the mirror tracing task, there was a significant effect of age $F(1,55) = 7.45$, $p<.01$, with older subjects having worse performance than younger subjects. The sex effect was non-significant $F(1,55) = 0.09$, $p=.77$. The condition effect was non-significant $F(2,55) = 2.66$, $p=.08$, performance was best in the dog condition and worst in the alone condition as shown in Figure 9.7. No higher order interactions between factors were significant.

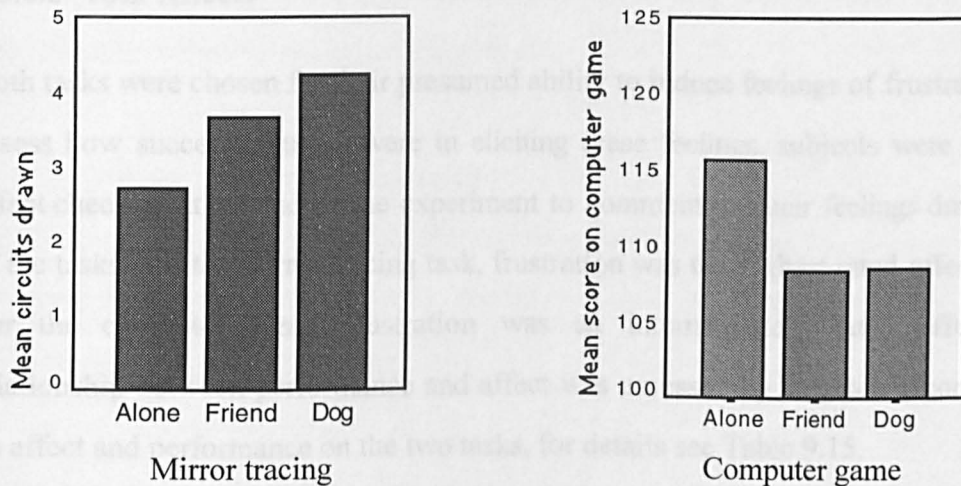


Figure 9.7 Performance in the mirror tracing and computer game tasks

For the computer game task, performance data was affected by factors of age and sex as anticipated. The age effect was significant $F(1,55) = 10.21, p < .01$ with older subjects again performing worse than younger subjects. The sex effect was significant $F(1,55) = 8.30, p < .01$, with males being better at the computer game task than females. The main effect of condition was non-significant - $F(2,55) = 0.19, p = .82$, all experimental groups performed similarly, see Figure 9.7. There was a three way interaction between sex, age and condition $F(2,55) = 3.55, p = .04$. A posteriori Tukey tests revealed that three pairwise comparisons were significant between the best and worst scoring groups. Young male subjects in the dog condition performed better than older females in both friend ($p = .01$) and dog ($p = .05$) conditions. Young males in the alone condition performed better than older females in the friend condition ($p = .05$). These pairwise differences seemed to reflect the broad better performance of the younger and/or male subjects. No other interactions were significant.

It did not seem that either task performance was adversely affected by the presence of a companion. In fact there was a strong trend for performance to be better in the dog present mirror tracing trials.

9.3.6.2 Task Affects

Both tasks were chosen for their presumed ability to induce feelings of frustration. To assess how successful tasks were in eliciting these feelings, subjects were given an affect checklist at the end of the experiment to comment on their feelings during each of the tasks. For the mirror tracing task, frustration was the highest rated affect $p < .05$. For the computer game, frustration was an intermediately rated affect. The relationship between performance and affect was assessed by Pearson's correlations on affect and performance on the two tasks, for details see Table 9.15.

Table 9.15 Correlations between task affects and performance.

Affect	Performance	
	mirror tracing $n=55$	computer game $n=55$
Relaxed	.23	.15
Stressed	.02	-.12
Embarrassed	-.18	-.13
Angry	-.02	-.17
Confident	.36*	.43**
Skilful	.29*	.39**
Annoyed	-.14	-.02
Frustrated	-.32*	-.20
Successful	.35*	.38**
Frightened	.25	.00

Note. * = significant at $p < .05$, ** = significant at $p < .005$

Subjects who performed better on the mirror tracing felt significantly more confident, more skilful, less frustrated and more successful. Subjects who performed better at the computer game also felt significantly more confident, skilful and successful, but here there was no significant relationship between frustration and performance. The only significant correlation between affect and reactivity was heart rate reactivity and frustration to the mirror tracing task, ($r = .39$, $n = 55$, $p < .01$). Given the large number of

comparisons it could not be concluded that there were any definite relationships between affect and physiological reactivity.

In summary, the mirror tracing task appeared to induce feelings of frustration however the computer tracing task failed in this regard. Although task performance was related to affect, neither was consistently related to reactivity. There were no condition differences in performance.

9.3.7 Subjective aspects of the experiment

Given that clear effects were shown on moderation of reactivity by both companion conditions, it was of great interest to examine whether the subjective evaluations had picked up any condition differences. Subjects were asked to rate a number of features of the experimental setting and the experimenter on a 1 to 6 scale. These questions were grouped into four sections - items relating to their impressions of the experimental setting, view of the experimenter, their ability to perform on the tasks and questions which might indicate social support or other effects of having a companion present.

9.3.7.1 Formality

It was expected that subjects who had a companion might find the setting more relaxing, pleasant, informal and less serious. The condition means for these ratings are given in Table 9.16. None of the comparisons reached significance, suggesting that the experimental set-up was similarly perceived in each condition.

Table 9.16 Subjects' threat ratings

Item	Scale anchor points		Control	Friend	Pet Dog	Analysis
	1=	6=				
Experimental setting was	very unpleasant	very pleasant	4.7 (1.0)	4.6 (1.1)	4.7 (1.1)	$F(2, 63) = 0.60, p=.94$
Experimental setting was	not at all relaxing	very relaxing	4.2 (1.2)	4.5 (1.2)	4.4 (1.4)	$F(2,63) = 0.40, p=.67$
Experimental setting was	very humorous	very serious	4.0 (0.8)	4.6 (1.1)	4.2 (1.0)	$F(2,63) = 2.37, p=.10$
Experimental setting was	very formal	very informal	3.9 (0.9)	3.4 (1.4)	3.7 (1.2)	$F(2,63) = 0.77, p=.47$

Note. Group means with standard deviations in parentheses are shown. Data missing for one subject in the friend condition.

9.3.7.2 Perception of experimenter

It has been reported that people associated with animals are more highly rated on positive tendencies such as friendliness etc. In experiment three, trends had been found which suggested that the experimenter was perceived as being more likeable and more reassuring. In the third experiment, the experimenter had been acting as a 'pet owner' i.e. accompanied by what was perceived to be her own dog, therefore, it was an empirical question as to whether similar effects would be found when she was just interacting with the subject's own dog. However there was no evidence for this occurring, as all impressions of the experimenter were even between groups, see Table 9.17.

Table 9.17 Subjects' perceptions of the experimenter

Item	Scale anchor points		Control	Friend	Pet Dog	Analysis
	1=	6=				
Experimenter was	very intimidating	very reassuring	4.9 (1.0)	5.1 (1.0)	5.0 (1.0)	$F(2, 63) = 0.43, p=.65$
Experimenter seemed	very relaxed	very nervous	1.5 (0.8)	1.6 (0.9)	1.9 (1.0)	$F(2, 63) = 1.07, p=.35$
Experimenter seemed	very chatty	not at all talkative	3.7 (1.1)	3.8 (1.7)	4.1 (1.5)	$F(2, 63) = 0.44, p=.64$
Experimenter was	very friendly	very unfriendly	1.6 (0.9)	1.6 (0.8)	1.6 (0.7)	$F(2,63) = 0.05, p=.95$
Experimenter made me feel	very relaxed	very much on edge	2.0 (0.8)	1.7 (0.8)	1.8 (0.8)	$F(2,63) = 0.48, p=.62$
Experimenter was	very likeable	not at all likeable	1.8 (0.8)	1.5 (0.7)	1.6 (0.7)	$F(2,63) = 0.98, p=.38$

Note. Group means with standard deviations in parentheses are shown. Data missing for one subject in the friend condition.

9.3.7.3 Distraction

It was predicted that subjects with a companion present might find it less easy to concentrate on the experimental tasks due to distraction. This could be especially true for those with a dog present. However, these ratings also did not differ between conditions, see Table 9.18.

Table 9.18 Subjects' subjective ability to concentrate on tasks.

Subjective ability to concentrate on:	Alone	Friend	Dog	Analysis
mirror tracing	3.7 (1.8)	4.4 (1.7)	3.7 (1.8)	$F(2,62) = 1.12, p=.33$
computer game	4.8 (1.4)	5.3 (1.0)	5.1 (0.9)	$F(2,62) = 0.75, p=.48$

Note. Group means with standard deviations in parentheses are shown. Data missing for one subject in the friend condition and one subject in the dog condition.

9.3.7.4 Social support

Social support has been proposed as one mechanism by which stress moderation occurs. Some subjects reported feeling supported by their companions:

S19 "I thought it would be relaxing by having someone with me I knew"

However, when directly asked about this, subjects did not differ in their perceptions of being supported between conditions or differ in their reports of feeling isolated or feeling able to complete the tasks well.

Table 9.19 Subjects' support ratings

Item	Scale anchor points		Alone <i>n</i> =22	Friend <i>n</i> =22	Dog <i>n</i> =23	Analysis
	1=	6=				
Felt confident in ability	completely agree	completely disagree	3.3 (1.3)	3.0 ^a (1.2)	2.8 ^a (1.1)	$F(2, 62) = 0.97, p=.39$
Felt isolated & alone	completely agree	completely disagree	4.5 (1.4)	4.7 ^a (1.6)	4.7 (1.4)	$F(2, 63) = 0.26, p=.77$
Felt helped & supported	completely agree	completely disagree	2.6 (1.8)	2.7 ^a (1.5)	3.0 (1.5)	$F(2, 63) = 0.35, p=.70$
Felt evaluated by others	completely agree	completely disagree	3.3 ^a (1.6)	3.2 ^b (1.7)	3.0 (1.7)	$F(2, 61) = 0.17, p=.85$
Companion made me feel	very unsafe	very safe	-	2.5 ^c (0.9)	2.5 ^b (1.1)	$F(1,36) <.01, p=.99$
Having companion	disliked it intensely	intensely like it	-	4.1 ^c (0.5)	4.2 ^a (1.2)	$U(2, N=39) = 163.00, p=.45$
Concern for companion	very unconcerned	very concerned	-	1.3 ^c (0.6)	2.9 ^a (1.6)	$U(2, N=39) = 297.50, p<.01$

Note. Group means with standard deviations in parentheses are shown.

a = data missing for one subject in the group, b= lost data for two subjects in group,

c= lost data from 5 subjects in the group.

If as Allen *et al.* (1991) suggested, the presence of a dog is less evaluative than a friend, then it might be expected that subjects in the friend present condition would feel more evaluated. In the current experiment, efforts were made to make the friend's presence non-evaluative in that they were not allowed to see the subject's performance, performance was non-verbal, and they could not gauge the subject's performance from comments made by the experimenter. To check the effectiveness of this control, subjects were asked to rate how evaluated they felt. Subjects did not differ in their ratings of being evaluated in the conditions suggesting that the possible evaluation effect of the friend was not a problem.

Friedmann and Thomas (1985) have suggested that one way in which pets can decrease sympathetic nervous system arousal is via the feelings of safety that they induce. Due to an oversight, subjects in the control condition were not asked how safe they felt, however safety ratings did not differ between friend present and dog present groups suggesting that the dog did not provide any superior safety feelings than a human companion.

On average, subjects reported being equally as happy to have their friend as their dog with them. However, when the distributions of the two scores are examined, it can be seen that the range of responses for the dog group 1-6 was much greater than for the friend group 3-5. The standard deviations for the groups are correspondingly different. This suggests, not surprisingly, that subjects varied considerably in how they responded to having their dog present. Dog behaviour would seem to possibly be associated with this, as there were strong correlations between the owner's rating of their dog's behaviour and how happy they were having their dog with them ($r=.67$, $n=16$, $p<.01$). Subject's were less happy to have their dog with them if it was less well behaved.

Concern for the companion's presence differed significantly between the two groups. People reported being much more concerned about their dog's behaviour and therefore

finding it difficult to relax than about their friend's behaviour. The range of concern reported was also greater in the dog group than the friend group. No one in the friend present group reported more than 3 on the 1-6 scale of being concerned, whereas the dog present group reported all levels of concern. Subject's rating of their dog's behaviour was strongly related to their concern levels, ($r=.76$, $n=16$, $p<.01$). Subjects were more concerned about their dog if it was less well behaved.

The law of initial values (Wilder, 1967) proposes that when a subjects is more relaxed, he/she will react more strongly than when already slightly aroused. An elevated baseline estimate would moderate the following reactivity. Therefore if subjects in the dog present group on the whole found it less easy to relax than those alone or with a friend present, this might explain the reduction in reactivity. However this is difficult to assess without having a comparison reactivity for the same person in a no-companion condition. For example a very reactive person may have their reactivity moderated greatly, but it might still be higher than a very stressed less reactive person.

The baseline levels did not differ significantly between the groups. However it might be that, within the groups, those more concerned were relaxing less and had higher baselines. To examine this possibility, concern was dichotomised into groups of high and low concern. For friends, concern for most (12/16) subjects was the lowest possible option, the four subjects registering more concern than the minimum were put in the high concern group although these people were not in absolute terms that concerned either. For dog present groups, concern was dichotomised with the aim of producing two fairly equal sized groups. This meant subjects rating 1 or 2 concern levels were in the low concern group ($n=11$) and those rating higher concern in the high concern groups ($n=11$).

When considering the friend group, those more concerned had higher baseline systolic blood pressure $F(1,13) = 6.31$, $p=.03$, a strong trend for higher diastolic blood pressure $F(1,13) = 4.14$, $p=.06$ and strong trend for significantly higher heart rates

$F(1,13) = 3.66, p=.08$. Sex and age of subject were controlled in these analyses.

For the dog present group a similar pattern can be seen with more concerned subjects having higher baselines, although no results are significantly different SBP $F(1,18)=2.41, p=.14$; DBP $F(1,18)=1.80, p=.20$; HR $F(1,18)=3.08, p=.10$. Again age and sex of subject were included as covariates.

This suggests that concern for companion is an important factor, especially in experiments using animals and may affect estimates of baseline levels of cardiovascular activity. This is especially striking as the amount of concern did not vary much for subjects in the friend condition, who were all generally unconcerned.

9.4 Discussion

There were no differences across conditions in subjects' self-reported levels of loneliness or the quality of the specific nominated human or canine relationships. Therefore, group differences are unlikely to be due to pre-existing differences in social support. Groups were also balanced in regard to other pertinent physiological, demographic and pre-experimental behaviour variables.

Supporting a stress moderating effect of the presence of a human companion, systolic reactivity for the friend group was significantly lower than the alone group for the computer game task, and there was a strong but non-significant trend towards lower reactivity for the mirror tracing task. Diastolic blood pressure reactivity and heart rate reactivity followed a similar pattern but main effects of condition were non-significant. For younger subjects, heart rate reactivity to the computer game task was significantly lower than for the alone group, a similar, but non-significant effect was found for heart rate reactivity to the mirror tracing task.

The moderation of reactivity by the presence of a non-evaluative passive human presence, replicates results of a number of other studies (Kamarck *et al.*, 1995; Kamarck *et al.*, 1990; Kors *et al.*, 1997). In contrast to these studies which found similar sized effects on both systolic blood pressure and heart rate reactivity, in the current study, only effects on systolic blood pressure reached significance. The stress moderating effect sizes of a human companion are medium to small. Rejection of medium sized effects as non-significant may be more due to lack of power than meaningful acceptance of the null hypothesis. This suggests that the non-significance of the comparisons between alone and friend groups reflects an under-estimation of required sample size and therefore should not lead to acceptance of the null hypothesis. The number of subjects for the study was guided by effect sizes seen in similar studies on the effects of human and canine companions, see Section 5.3.1, p.113. However it is recommended that future studies should use sample sizes to detect at least medium effect sizes.

Supporting a stress moderating effect of the presence of a familiar companion animal, dog group systolic and diastolic blood pressure reactivity was significantly lower than the alone group, on both tasks. Main condition effects on heart rate were non-significant. The size of differences between groups indicates a large stress moderation effect on blood pressure reactivity and a medium effect on heart rate reactivity from the presence of a familiar dog.

The moderation of systolic blood pressure from the presence of the subjects own pet dog replicates the effect found in Allen *et al.*'s (1991) study of middle aged female dog owners. The current study however, found similar effects in both male and female participants and found significant moderation of diastolic blood pressure reactivity as well. The current study's findings are however in contrast to those of Grossberg *et al.* (1988) which also used the participants' own dog in a laboratory setting. The difference between these studies may be attributed to the lower power of the Grossberg study; the introduction of variance into the measurement by an inadequate

baseline measurement procedure and that no efforts were made to reassure participants that their dogs could not cause any damage in the laboratory setting. The current study was a more powerful design, used a more sophisticated baseline assessment procedure and also took great care to reassure participants that their dogs would come to, and could do no harm, in the experimental laboratory.

The differences between the Rajack study and the current study are more difficult to explain. Rajack's study had an adequate power and baseline assessment methods. However the difference may be attributable to the tasks used. Rajack had to test blood pressure just after the end of the stressor for two of the tasks, the stair test and alarm clock, and thus this may not have picked up condition differences. The other task of reading aloud might have been expected to detect condition differences, although, in this case, performance was not monitored and might have affected results. However, given the conflicting findings, it is suggested that further research should seek to clarify how robust the stress moderation effect of a dog is, and under what conditions it is seen.

No group differences were found with respect to cardiovascular recovery from the tasks. The tasks themselves had been selected to have frustrating qualities about them. This, it was hoped, would lengthen the recovery curve and thus increase the likelihood of condition differences becoming apparent. Self-report data indicated that the mirror tracing task was indeed perceived as frustrating by the participants, although the computer game was not. However recovery curves to both tasks demonstrated extremely quick return to baseline in all conditions. This recovery phase was swifter than found in similar experiments of Gillin *et al.* (1996) and thus it is unclear whether condition differences might have been found with a more suitable task. There is scope to explore the use of tasks which are more likely to provoke prolonged recovery, although the management of such tasks with either a human or canine companion would require careful consideration. An anger recall task is possibly one candidate.

The presentation of a human companion as being equally non-evaluative as a canine companion appears to have been successful. In Allen *et al.*'s (1991) experiment, no steps were taken to present the human as non-evaluative and thus it was presumed that this accounted for the higher reactivity in the presence of a human friend as compared to a canine companion. The results of the current experiment suggest that a human companion can be perceived as being as non-evaluative as a canine companion and in these circumstances both will produce a stress moderation effect. Also, it seems, that addition of a non-evaluative companion does not, in subjective terms, increase the evaluation felt by the participant over that in an alone condition.

Reduced formality of the situation is unlikely to account for the reduced reactivity in the companion present groups. If subjects in the companion present groups felt that the experiment was less serious, then they might be expected to react less to the tasks. Kamarck *et al.* (1995) have found that subjects tested in high threat situations react more strongly than those tested in lower threat situations and have suggested that a high threat setting is a boundary condition for social support effects to be seen. However, subjects self-report data indicated that they did not find the presence of either their dog or human companion to be associated with lower formality or seriousness of the setting compared to people tested alone. Overall ratings of formality, seriousness, pleasantness and relaxation were intermediate suggesting that there was no problem of ceiling or floor effects in ratings.

Distraction is unlikely to account for the resulting differences in reactivity, as all groups showed equivalent performances on the tasks. This was backed up by self-report data with subjects rating the conditions equivalent in terms of impeding their ability to concentrate on the tasks. This confirms findings from Kamarck (1990), Kamarck *et al.* (1995) and Edens *et al.* (1992) that a non-evaluative human presence does not seem to be a distraction affecting performance in objective terms. However, this experiment adds to these studies by suggesting that there is no subjective feeling of distraction, from either dog or human companion.

In the current experiment, participants in the dog present group had significantly higher heart rate baselines than the other two groups. This finding is reminiscent of that in the third experiment where in the open talk condition, significantly higher diastolic blood pressure baselines were found in the dog present condition as compared to the dog absent condition. One interpretation of these findings is that the presence of the dog caused a degree of uncertainty or arousal to participants and thus acted as a stressor during the rest period of the experiment. Supporting this suggestion, it was noted in the current experiment, that participant's concern for both human and canine companions was associated with trends to higher baseline levels. This finding is unusual, as other studies investigating effects of human companion have not found differences in baseline according to presence or absence of a human companion (e.g. Cacioppo & Tassinary, 1990; SnyderSmith & Cacioppo, 1992) and thus no effect on baseline levels was expected for either human or canine companions. However it suggests that attention to effects of canine companions on baseline levels may warrant attention in future experiments. This finding also gives weight to the caution of Grossberg & Alf and Vormbrock (1988) that pet owners concern about their pet in an unfamiliar setting may mask any stress moderation effects. Further companion animal studies should therefore be careful to reassure owners that their animals will not come to any harm and that they cannot damage the laboratory or upset the experiment. However, if this reassurance is necessary to obtain a stress moderation effect in the laboratory, it suggests that the situation is not ecologically valid and in a normal setting, the presence of one's own pet may act as a source of stress.

The experiment was unable to determine whether differences in baselines may have contributed to moderation of reactivity through some kind of effect such as that suggested by the law of initial values. Although this confound would not be removed by the use of baseline co-variates in analyses of reactivity, it is important to note that the moderation of reactivity by the presence of a companion was still preserved with the inclusion of this co-variate, suggesting that between-group differences were not

contributing to this effect.

That no distraction differences were found between conditions may account for why recovery differences were not found, as it was proposed that recovery might be hastened if any ruminative tendencies were distracted. However, this experiment also did not find any evidence to support the consideration that rehearsal tendencies, as measured by a modified ECQ subscale, are related to delayed recovery, so the question remains open.

Kamarck *et al.* (1990) suggested that if in verbal tasks, vocal intensity is moderated by the presence of a companion, this might underlie condition differences. This may be particularly the case when a pet is present, as they are more likely to react adversely to loud verbal interchanges and thus pet owners might moderate their voices in their presence. The other experiment (Allen *et al.*, 1991) which found reactivity moderation from the presence of a dog, used a verbal task. They did not systematically monitor vocal intensity or pace and so were not able to investigate the possibility that reactivity differences were attributable to differential vocal stylistics in the conditions. In the current experiment, two non-verbal tasks were used and both found moderation of reactivity in a companion animal present condition as compared to an alone condition with both non-verbal tasks. Therefore differences in vocal stylistics can be discounted as a possible explanation in this study.

This experiment although discounting certain explanations, is unable to clearly determine why subjects have lower reactivity in the presence of a dog. Reduced formality, distraction, concern for dog, or differing vocal stylistics are all unlikely explanations. However, whether the explanation is some form of social support is unclear. There were no differences in group ratings which might indicate certain aspects of what might be termed social support. Thus people tested in the alone, friend and dog conditions reported similar feelings of 'support', confidence in ability and isolation. This replicates findings of Kamarck *et al.* (1995) who also found that

these items did not differentiate subjects who showed a cardiovascular stress moderation from human social support. It seems, therefore, that either these items are not sensitive to the provision of support, or that the mechanism underling this moderation is not a form of social support, or that the effects are supportive but below the participants conscious appreciation. It is difficult to design items which might reflect support provided by the companion, as they are merely present in the room and do not interact with the participant. It suggests that any support effect may reside in a pre-existing expectation of support rather than an actual support transaction in the experimental setting. The entire set-up of this type of experiment calls into question issues of ecological validity, and it seems more debate is warranted before acceptance that moderation of reactivity to a cognitive task in the presence of a passive, uncommunicative and non-evaluative companion is analogous to provision of support in everyday settings and is linked to health benefits of human or companion animal relationships. This is an issue which will be returned to in the general discussion.

Chapter Ten

Discussion and Summary

This thesis is rooted in the association between pet ownership and health benefits. The evidence for an association was reviewed in Chapter 4, and the conclusions were that, although the evidence is mixed, the variety of studies suggesting benefits warrant further investigation. In particular the strongest evidence seems to be for cardiovascular health benefits of pet ownership. Also discussed in Chapter 4 are the proposed mechanisms underlying any health benefits. The mechanism focused upon in this thesis was that of cardiovascular stress moderation from the presence of a companion animal. As described in Chapter 2, cardiovascular reactivity has been studied due to the links made between high reactivity and later cardiovascular pathology (Krantz & Manuck, 1984). Cardiovascular reactivity moderation from human relationships has recently been proposed as a mechanism underlying the established health benefits of human-human relationships (Uchino *et al.*, 1996). The evidence for a link between human-human relationships and health was reviewed in Chapter 3, along with a review of the experimental literature investigating the effects of the presence of a human companion on cardiovascular reactivity. The conclusions from the review of this body of experimental literature are that the presence of a supportive companion can reduce cardiovascular reactivity to stressors, although there are boundary conditions for this effect and its link to real life situations warrants further consideration.

The current programme of research was prompted by the discrepancy between the theory that pets reduce stress levels and the mainly non-significant body of experimental literature investigating this issue. Although this might lead to the conclusion that stress reducing effects of companion animals are an urban myth,

consideration must be taken of the standard of the experimental studies which seem to show mixed and no effects. The experimental literature was reviewed in Chapter 5, and the lack of methodological rigour was highlighted. Additionally, even if the presence of a companion animal was shown to have a stress moderating effect in a laboratory setting, an examination of the mechanisms which underlie this effect should be made to determine whether it could be generalised to pet owners in their everyday lives. The studies in this thesis have aimed constructively to further this research area on stress moderation from a companion animal, by using refined methodology, examining effects of unfamiliar and familiar dogs and examining the underlying mechanisms. This chapter outlines the main findings in each area, highlights limitations and discusses possible opportunities for further research.

10.1 Summary of main findings

10.1.1 Methodological standards in companion animal reactivity studies

The literature review in section 5.3, identified a number of specific methodological shortcomings of previous companion animal cardiovascular reactivity studies. These methodological weaknesses would be expected to introduce extraneous variance into both baseline and task measurements which may mitigate against detecting stress moderation effects. Some companion animal studies have also been of insufficient power to detect as significant anything less than the largest stress moderation effects. The introduction of extraneous variance and the low power may account for the large number of studies which have found non-significant effects of companion animal presence. Additionally, the length of acclimatisation period was highlighted as a factor which might account for the contrary results of some previous studies.

It was imperative for constructive extension of this research area that these methodological aspects be refined. This thesis sought to establish appropriate

standards for further companion animal reactivity studies. Companion animal studies should be of a similar standard to those recommended for mainstream reactivity studies, although it is noted that even within the mainstream reactivity studies, there is a wide variation in current practice. However, from a review of expert guidelines and methodological enquiries, the following recommendations can be made: studies should balance or check equivalence across experimental conditions of stable and acute participant characteristics which may affect participants' cardiovascular baseline and reactivity levels; studies should allow a sufficient acclimatisation period for participants' baseline levels to stabilise prior to a baseline assessment (this issue is discussed further in Section 10.1.2); studies should take at least three measurements from which to assess baseline and task levels; and if using tasks with a verbal component, they should standardise or monitor participants' vocal stylistics. Additionally, it is recommended that future studies investigating effects of presence of canine companions on cardiovascular variables use designs reasonably likely to detect at least medium sized effects. Application of these standards to future studies should enable the area of research to gain more credibility and hopefully to resolve mixed findings.

10.1.2 Baseline assessment techniques

One of the methodological issues which was given most attention was that of baseline assessment. Baseline assessment can be seen as the cornerstone of reactivity analysis and failure to perform this step of the experiment correctly can render reactivity analysis meaningless. Companion animal studies have used various dubious techniques to assess baseline levels, although it was highlighted that both general reactivity practice and 'expert' guidelines differ as to the best procedure to use. An acclimatisation period needs to be allowed prior to baseline measurements, but there is no accepted guidance as to its required length. Therefore this thesis aimed to resolve this dilemma.

The second experimental study monitored acclimatisation of cardiovascular variables to a laboratory setting over a twenty minute period. A number of techniques were used to examine at what point acclimatisation had occurred. Examination of temporal stability of different baselines, a technique used by Jennings *et al.* (1992), and examination of statistical difference of successive baseline estimates, as used by Goodman, Dembroski and Herbst (1996) were applied to the dataset. The second experimental study also introduced the technique of fitting an exponential curve to this data. This analysis has not been attempted in any other published cardiovascular reactivity studies which could be found. An exponential curve seems an appropriate physiological model and also has a very close fit to the observed data, with variance explained in the region of 95%. Use of an exponential curve allows calculation, for a sample, of the theoretical level gained should measurements continue ad infinitum. From this premise, one can calculate the time required for cardiovascular levels to acclimatise to levels which do not differ substantially in either absolute or percentage terms from the final limiting value. Whether the levels achieved by this process are indicative of a stable level of pre-stress cardiovascular levels, or a valid proxy for basal unstressed resting levels of cardiovascular activity, is debatable. However even if levels obtained in a pre-task baseline do not approximate basal levels, these guidelines still hold for obtaining the realistic lowest and most stable levels of activity within a reasonable time-frame.

Application of these analyses to the dataset in experiment two, which was based on a sample aged from 18-41 years with the majority of participants (89%) aged between 18 and 30 years, suggests that the optimum time to allow for acclimatisation is eight minutes. These analyses established that the general recommendations of fifteen minutes or longer may be unnecessary for the student population typically used in reactivity studies. Procedures in these studies may be confidently shortened in the expectation that after a certain time no further meaningful decrease in levels or increase in stability will result. A shorter experiment is more desirable for participants and may prevent boredom which could increase the instability of measurements.

Further analyses of data from experiments three and four suggest that modified standards might be required for different aged populations of participants. From analyses of data from the last three studies presented in this thesis, tentative recommendations can be made that five minutes be allowed for acclimatisation of a typical 18-21 year old undergraduate study population, ten minutes for a population (20-40 years) and fifteen minutes for a population over 40 years. Further research could see if these conclusions generalise to other normotensive populations. Additionally, the use of continuous measurement devices would allow greater understanding of the process of acclimatisation.

10.1.3 Stress reduction from an unfamiliar companion animal

The thesis presents three studies which have examined whether there is any reactivity reduction from the presence of an unfamiliar companion animal. Previously mentioned methodological refinements were incorporated and power levels were sufficient to detect a medium to large effects. The combined picture from all three studies suggests that the presence of an unfamiliar companion animal neither reduces cardiovascular levels throughout the experiment nor specifically reduces reactivity. A Dutch study (Straatman *et al.*, 1997) published after the start of these three studies using a similar set-up also found no stress moderation from the presence of an unfamiliar dog. Therefore it would seem that this formula does not produce stress moderation and further experiments in the same vein are not warranted.

As highlighted, there are a number of designs used in previous research and this thesis examined only one formula, testing in a laboratory setting, on cognitive stress tasks using adult participants and a between-subjects exposure involving an unfamiliar dog. Therefore it does not rule out that effects might be seen if some of these factors were modified. The contribution of experiments involving unfamiliar animals would seem to be in modelling the use of animals in treatment settings. Therefore the use of more naturalistic stressors and subjective or behavioural indices of stress may be more

appropriate than physiological indices. For instance the recent studies of Nagengast *et al.* (1997) and Hansen *et al.* (in press), which have examined children in treatment settings where it is possible that a child might encounter an unfamiliar animal, seem an appropriate line for this research area to take.

The use of an unfamiliar companion animal reflects the view by Friedmann (1995) that the stress moderation effects of companion animals should be seen in anyone, not just those who 'own' the animal. However, if health benefits of pets are due to the nature of the relationship, then it is difficult to see what application studies using an unfamiliar companion animal have. It should also be noted that previous studies of Friedmann *et al.* (1983b) and Locker (1985), which found effects using an unfamiliar animal, do not provide any basis for an extension of social support concepts to benefits of pet ownership via physiological means. Therefore it seems that, in terms of examining benefits of pets to their owners, experiments with the person's own pet are necessary. That a stress moderating effect is not seen in experiments with an unfamiliar animal might suggest that any stress moderation, if it exists, is rooted in the nature of the relationship between the person and their pet.

The failure of any of the studies to demonstrate stress moderation effects reduces the salience of some of the subjective effects which were found in the third experiment. Although some evidence was found for a reduced threat value of the experiment and setting, and a more positive evaluation of the experimenter, in the dog present as opposed to alone conditions, these effects need both replication and support by a concurrent cardiovascular stress moderation before they can be accepted as a mechanism underlying any effect.

However the findings do establish that perceptions of people are positively affected by the presence of a companion animal and this may underlie social catalysis effects reviewed in Section 8.1.1. Although previous studies investigating this effect have noted a more positive evaluation of people seen in pictures with animals, this is the

first study to examine and find that perceptions of people are more positive in an actual interaction when a dog is present.

10.1.4 Stress moderation from human friends

The final experiment found weak evidence for the conclusion that the passive presence of a non-evaluative human companion leads to moderation of participant cardiovascular reactivity compared to an alone condition. This finding is consistent with other studies involving a passive non-evaluative human companion which also found moderation of cardiovascular reactivity (Gerin *et al.*, 1995; Kamarck *et al.*, 1995; Kamarck *et al.*, 1990; Kors *et al.*, 1997).

The conclusion of these other studies is that the mechanism which underlies this effect is social support, and furthermore that this provides the link between the hypothesis that higher cardiovascular reactivity is linked to ill health (Krantz & Manuck, 1984) and studies which demonstrate that people with more close contacts are in better health (House *et al.*, 1988a). The proposal is that, if a friend provides a regular dampening of cardiovascular reactivity, then this may explain the link between social support and health (Kamarck *et al.*, 1990). However to satisfy this conclusion, the studies would need to demonstrate that they are appropriately representing both stress seen in real life, and social support transactions, and that no other more parsimonious explanation might account for this effect.

The use of stress tasks in laboratory situations to model stress of every day life is a well established paradigm. This reflects the ethical problems in representing realistically stressful events in a laboratory situation. It also reflects an assumption that the cardiovascular responses seen to laboratory stressors are similar to those seen in real life situations when people are confronted with a stressful experience. However it should be noted that the laboratory task is usually an acute stressor lasting a few minutes in both psychological and physiological terms, whereas a real life stressor

may last for hours with no clear onset and offset, have psychological sequelae and a range of hormonal and neural responses which do not just reflect the acute fight or flight response of cardiovascular activation seen in laboratory settings. Although people who experience stressful events are subject to more health problems, it seems that this may come from other aspects of the stress response than just the acute physiological cardiovascular response. That a laboratory stress task reflects an appropriate model for real life stress is therefore an arguable point. However this is an assumption which is accepted by all studies which measure cardiovascular reactivity to cognitive stress tasks in the laboratory.

The notions of social support raised in experiments with a passive companion are different to those commonly included in the theoretical definitions of social support or, more importantly, to those aspects of social relationships measured in studies which find a link between social relationships and health benefits. Social support experiments which involve the passive presence of a person find that stress moderation effects are only found from friend and not stranger presence. This social support therefore seems to reside in the previous transactions of support, as in the experiment there is no interaction between the companion and participant. In these experiments, the participant is made non-evaluative. This type of scenario seems far removed from events in real life, as it is difficult to conceive of a situation where your friend would be in close proximity to you when you are stressed by something, but be unable to monitor your performance. Additionally, it would be unusual if, under stressful circumstances, a friend did not try to provide some form of active support in the way of non-verbal or verbal communication. Therefore it seems unlikely that the current experiments are adequately reflecting support scenarios seen in real life.

If the mechanism involved is not social support, then what could it be? Social facilitation and affiliation studies, some which pre-date studies which invoke a social support explanation, found physiological effects of companions. Social facilitation theories suggest that the mere presence of others will be inherently arousing either due

to the unpredictability of their behaviour (Zajonc, 1980), only in scenarios when they are evaluative (Cottrell, 1972) or due to attention conflict (Baron, 1986). However a meta-analysis found that the presence of a friend was actually less arousing than that of a stranger, although effect sizes were small (Bond & Titus, 1983). Studies coming from an affiliation paradigm (Schachter, 1959; Schachter, 1974), in contrast, found that those who are stressed prefer to be with others who are also stressed, presumably as this reduces stress. However this does not explain why presence of others reduces stress.

One theory of Kissel's (1965), is that friends constitute an emotionally pleasing stimulus which competes with the negative emotions produced by a stressor and therefore reduces arousal. Kissel's experiment was conducted over 25 years prior to Kamarck *et al.*'s (1990) experiment which appealed to the process of social support to explain a similar reduction in autonomic arousal produced by a friend's presence. Although having friends generally may result in health benefits, and having friends present in a laboratory situation may lead to a reduction in autonomic arousal, this does not necessarily prove that the same mechanism is occurring. Given the differences in the proposed scenarios, - an evaluative actively supportive friend in a real life stress situation versus a non-evaluative passive friend in a laboratory situation, it argues against applying the same explanation.

What seems more pertinent is not whether an effect is due to distraction, social support or reduction of threat, but rather whether that effect could translate to an everyday occurrence. In this case it seems that the presence of a supportive but non-evaluative friend would rarely translate to a regular dampening of cardiovascular reactivity in real life situations, and therefore it does not matter what you call it, it is not going to affect health.

10.1.5 Stress reduction from pet dogs

The final experiment found strong stress moderation effects of the presence of a person's own pet. The result is consistent with the one previous published study (Allen *et al.*, 1991) which has investigated stress moderation effects of the person's own pet. The current study is, however, able to discount explanations that the effect is due to differences in vocal stylistics and extends these findings to a wider age group and to both sexes. It is also important in establishing that self-report indices of perceived threat of the situation, subjective distraction, objective performance, feelings of evaluation, perceptions of task related support, and perceptions of the experimenter were similar in both companion conditions and to an alone condition.

If a similar magnitude moderation is seen in experiments using a companion animal as that seen with a human friend, and self-report measures are similar for a number of potential explanations, then the alternative conclusions seem to be: a) if the mechanism behind the human companion effect is social support, then the pet is also capable of providing social support; b) the same mechanism is operating in both the companion conditions, but it is not social support; or c) there are different mechanisms operating in the two companion conditions, but these are not differentiated by assessments used in the current study.

The findings offer support to those attempting to model person-pet relationships in the same vein as human-human relationships. In chapter 4, a theoretical analysis suggested that the type of relationship which some people have with their pets may be interpreted as providing aspects of what in a human-human relationship would be called 'social support'. The results of the current study suggest that the person-pet relationship is also able to offer the type of support that may have physiological stress moderating effects similar to that suggested for human relationships (Kamarck *et al.*, 1990). However, for this effect to generalise to normal circumstances, the pet would have to be in close proximity during a stressor. Although it is possible and likely that we are surrounded by human friends during the time of stressors, it would

seem more unlikely that pets are present during stressful situations. Additionally the current study took great pains to reassure owners that their pets would not come to any harm and would not be able to cause any harm in the laboratory setting. It is possible that in the absence of this reassurance, the presence of a pet during a stressful event may be an additional source of stress due to concerns of being responsible for the pet. Therefore even if social support is the mechanism responsible for stress moderation in a laboratory, it does not seem that this will provide the 'regular dampening' integral to the rationale which links human stress moderation to health benefits in real life.

If the stress moderation from the presence of the dog was not due to social support, then other explanations need to be considered. It does not seem to be that stress moderation is caused by a reduction in threat, as threat ratings were similar across all conditions. Distraction would seem to be consequence of having either a companion or a novel stimulus of any kind in a laboratory setting. However in the current study, there does not seem to be a distraction effect of a companion as indexed by either objective performance or subjective ratings of distraction or, if distraction-conflict theory is correct, by increases in reactivity in the companion conditions. Concern for the companion was higher in the dog present condition, and it is suggested that this may prevent people in the dog condition relaxing fully and therefore may have attenuated subsequent reactivity in a law of initial values type of mechanism. This type of mechanism may arise in both human and canine companion situations, and requires investigation.

Increased rapport from the additional interaction which was required to settle both the human and canine companions as opposed to the alone conditions cannot be ruled out by this research programme. Experience from studies two and three of monitoring and assessing audio-taped interaction suggested that it was not possible to completely standardise the greeting phase of the experiment, and that monitoring the interaction would require both audio and visual monitoring of verbal and non-verbal

communication. It is not possible to determine from the published reports of studies of human social support whether steps were taken to control levels of interaction produced by the different companion conditions. In the final experiment, control of interaction was hampered by having only one experimenter who therefore had to greet the two participants who arrived together and could not be separated. It was undeniable that more interaction occurred in the companion conditions and especially in the dog conditions with the added requirements of settling a dog in an unfamiliar setting. This would appear to represent the greatest threat to a social support explanation of moderation of reactivity from the presence of a companion.

At present it appears that the same mechanism underlies the stress moderation seen in both companion conditions. However, it is possible that the measurements in this study were not sensitive to pick up condition differences. If this were the case then it does not seem to be a failing peculiar to this study, as previous experiments on human companions have also failed to find subjective effects which match cardiovascular effects. A notable exception to this is the study of Gerin and Pickering. (1995), which was the only one to compare subjective measures across companion sessions in a within-subjects design. This would suggest that a within-subjects design is more sensitive to these effects both due to increased power for the same number of subjects but also as each person can use their own feelings as a reference point (Gerin & Pickering, 1995). A within-subjects assessment of pet effects in one session would seem to be confounded by participants' concern regarding their pet in the 'no dog' phase of the experiment. This suggests that a within-subjects experiment over two sessions would be the most fruitful to pursue. This may highlight condition differences between human and dog companions which might suggest that different mechanisms are operating. Whether either of the mechanisms are social support is, again, debatable.

10.1.6 Health benefits from pet ownership

The brief from the industrial sponsor was to investigate the experimental research area of companion animals in cardiovascular reactivity experiments. This is not necessarily the same as investigating the claims made for health benefits of pet ownership. Moderation of reactivity is not the only potential way in which pets might reduce their owners' stress levels. In fact, moderation of reactivity is a mechanism which is far from the mind of the average pet owner when asked if their pet reduces their stress levels or has any health benefits. Investigation of the literature on effects of stroking pets suggests that this research area is equally confounded by poor design, mixed results and extensive interpretation such that a reputation for stroking pets reducing blood pressure has built up without any firm experimental evidence (Dunn *et al.*, 1998). However, future studies could examine the role of pets in stress moderation by providing a respite from hassles of daily life, relaxation and emotional interaction. These functions may be closer to the actual role that pets have in their owners' lives. It is also arguable that the examination of health benefits should be extended to quality of life issues which are encompassed in modern definitions of health and where it may be easier to establish benefits from pets.

Widening the question further, research might examine some of the confounding explanations identified in Chapter 4 which might account for any association between pet-ownership and health. This might include the role of socioeconomic status, exercise habits, personality traits and increased numbers of human acquaintances due to social catalysis effects. This suggestion seems particularly important since the majority of studies on health benefits of pet ownership are either carried out exclusively on dog-owners, or find stronger effects in dog-owners than owners of other species, and as these confounding explanations would have a greater effect on or are restricted to dog-owners.

10.1.7 Conclusion

The presence of a person's own pet may result in stress moderation as evidenced by moderation of cardiovascular reactivity to a laboratory task. It is arguable whether the mechanism underlying this effect is that of social support. It is equally arguable that the mechanism underlying stress moderation from the presence of a non-evaluative, passive, human companion is social support. However, even if the mechanism in the animal experiment is social support, the irregularity of pet presence during stressful events would seem to preclude this effect from accounting for health benefits which are reported for pet-owners.

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This thesis has been formatted in accordance with the guidelines from the Graduate school office, University of Warwick. References have been formatted in accordance with APA Publication Guidelines (APA, 1994).

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Appendix A: Math task questions for experiment one

The math task was presented on computer using the hypercard program. Each question was shown for 15 seconds and participants were required to write their answers on a sheet.

$$2+6+4-6-3-1$$

$$5+7+4+8+3+4$$

$$12-4-5+3+9-6$$

$$5-7+4+2-2-8$$

$$1+6+8+2+5-7$$

$$-7+5-2+4-5-7$$

$$8+2-10+3-9-3$$

$$9-10+8-2-6+4$$

$$8-5+10-6-10-9$$

$$10+8-6+7+9+6$$

$$4+3-2+2+2-1$$

$$2+1-3-2+3-5$$

$$-4-3+6-10+3-9$$

$$9-7+3+6-9-3$$

$$-3+6-6+2+4-2$$

$$-9+10-4-8+7+3$$

$$8+2-8+6-4-5$$

$$-10+9+5+8+2-6$$

$$9-4-6-9+10+5$$

$$9+6-7+4+10-3$$

Appendix B: Description and specification of the Critikon Dinamap™ model 8100

The Critikon Dinamap™ model 8100 is a portable vital signs monitor. It uses the oscillometric technique to measure blood pressure and heart rate. This is a non-invasive technique where a blood pressure cuff is usually placed over the subjects' brachial artery.

At the start of the measurement sequence, the blood pressure cuff is inflated to a pressure of 178 mmHg for an adult. The pressure in the cuff is then decreased in steps as shown in Figure 1. A transducer measures the cuff pressure and the oscillations in the pressure caused by the blood flow. The monitor samples twice at each pressure stage to reduce the effect of any movement artefacts. The time at each pressure stage depends on the time between pressure pulses - the subject's heart rate. However, the maximum time between stages is set at 1.6 seconds i.e. a pulse rate of 37.5 bpm. The deflation continues until the diastolic blood pressure is detected.

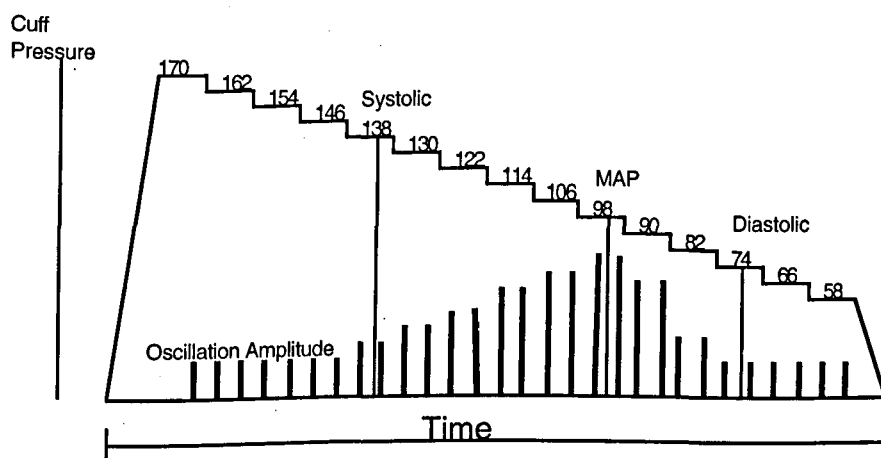


Figure 1 Blood Pressure Determination Sequence. Adapted from Critikon (1998: 21).

At cuff pressures below the diastolic blood pressure, no pressure oscillations would be sensed as the blood flow would not be impeded. At pressures above the systolic blood pressure, the blood flow would be completely stopped and no oscillations would be detected. At intermediate pressure levels, there would be oscillations in the cuff pressure caused by the blood flowing against the cuff. The greatest pressure oscillations are felt at the level of the mean arterial pressure. The time between oscillations is used to determine heart rate.

A typical time for determination is 20-45 seconds, with 120 seconds being the maximum time length, after this the monitor will time out and an alarm will sound [Critikon, 1988]. The manufacturers report the most recent reliability of the Critikon Dinamap for blood pressure determination as being equal to or exceeding the AAMI standards of ± 5 mmHg mean error and 8 mmHg standard deviation, heart rate accuracy is $\pm 3.5\%$ (Critikon, 1988).

Appendix C: Demographic questionnaire used in experiment one

Please fill in or circle as appropriate.

1. How old are you? 18-24 25-34 35-44 45-54 55+

2. How would you rate your health? Excellent Good Fair Poor

3. Do you take regular exercise
(3 twenty minute periods per week)? Yes No

4. Do you smoke? Yes No

If yes, have you smoked in the two hours before the
experiment? Yes No

5. Do you drink alcohol? Yes No

If yes, how much on average per week?

pints of beer / lager / bitter glasses of wine
measures of spirits other

If yes, have you drunk alcohol in the two hours before the
experiment? Yes No

6. Are you taking any medication? Yes No

If yes please specify

7. Have you had anything to eat or drink (alcoholic or non-
alcoholic) in the two hours before the experiment? Yes No

If yes, please specify

8. Are there any pets in your household? Yes No

If yes, please specify

9. How would you rate your attitude towards dogs?

Dislike Do not Tolerate No feelings Like Like dogs Like dogs
dogs like dogs dogs about dogs dogs a lot intensely
intensely at all

Appendix D: Branston- the dog used in experiments one, two and three



Branston on his beanbag



Branston in position for the experiment

Appendix E: MANOVA in experiment one

The main analysis was a six way multivariate analysis of variance (MANOVA) with three dependent variables of systolic BP, diastolic BP and heart rate. The factors were GROUP with three levels (control; music; dog); ORDER with two levels which indicates in which order the tasks were presented for each participant (order1, math then read; order2, read then math); AGE (young, 25-44 years; old 45+ years); SEX; TASK-TYPE with two levels (math; read) and PHASE with two levels (baseline level; task level).

MANOVA N=80	Wilks Λ	F	df	p
SEX	0.75	6.95	3,61	<.01
GROUP	0.91	1.02	6,122	.42
ORDER	0.89	2.46	3,61	.07
AGE	0.87	3.13	3,61	.03
SEX*GROUP	0.92	0.88	6,122	.51
SEX*ORDER	0.95	1.11	3,61	.35
SEX*AGE	0.91	2.05	3,61	.12
GROUP*ORDER	0.93	0.78	6,122	.58
GROUP*AGE	0.91	1.04	6,122	.40
ORDER*AGE	0.99	0.28	3,61	.84
GROUP*ORDER*AGE	0.94	0.69	6,122	.66
PHASE	0.16	103.96	3,61	<.01
PHASE*SEX	0.99	0.28	3,61	.84
PHASE*GROUP	0.84	1.86	6,122	.09
PHASE*ORDER	0.95	1.14	3,61	.34
PHASE*AGE	0.89	2.44	3,61	.07
PHASE*SEX*GROUP	0.93	0.72	6,122	.63
PHASE*SEX*ORDER	0.97	0.63	3,61	.60
PHASE*SEX*AGE	0.93	1.44	3,61	.24
PHASE*GROUP*ORDER	0.88	1.31	6,122	.26
PHASE*GROUP*AGE	0.95	0.58	6,122	.75
PHASE*ORDER*AGE	0.86	3.33	3,61	.03
PHASE*GROUP*ORDER*AGE	0.94	0.69	6,122	.66

Effect	Wilks Λ	F	df	p
TASK-TYPE	0.80	5.25	3,61	<.01
TASK*SEX	0.86	3.30	3,61	.03
TASK*GROUP	0.92	0.90	6,122	.50
TASK*ORDER	0.76	6.27	3,61	<.01
TASK*AGE	0.97	0.66	3,61	.58
TASK*SEX*GROUP	0.84	1.90	6,122	.09
TASK*SEX*ORDER	0.95	0.99	3,61	.41
TASK*SEX*AGE	0.95	1.09	3,61	.36
TASK*GROUP*ORDER	0.92	0.91	6,122	.49
TASK*GROUP*AGE	0.95	0.58	6,122	.75
TASK*ORDER*AGE	0.88	2.66	3,61	.06
TASK*GROUP*ORDER*AGE	0.89	1.27	6,122	.28
TASK*PHASE	0.65	10.76	3,61	<.01
TASK*PHASE*SEX	0.89	2.52	3,61	.07
TASK*PHASE*GROUP	0.93	0.76	6,122	.60
TASK*PHASE*ORDER	0.78	5.59	3,61	<.01
TASK*PHASE*AGE	0.94	1.38	3,61	.26
TASK*PHASE*SEX*GROUP	0.89	1.22	6,122	.30
TASK*PHASE*SEX*ORDER	0.97	0.65	3,61	.59
TASK*PHASE*SEX*AGE	0.95	1.07	3,61	.37
TASK*PHASE*GROUP*ORDER	0.96	0.37	6,122	.90
TASK*PHASE*GROUP*AGE	0.93	0.75	6,122	.62
TASK*PHASE*ORDER*AGE	0.96	0.93	3,61	.43
TASK*PHASE*GROUP*ORDER*AGE	0.95	0.51	6,122	.80

Appendix F: Math task questions for experiments two and three

The math task was presented on computer using the hypercard program. Each question was shown for 15 seconds and participants were required to write their answers on a sheet.

$$10-4+6+1-2+4$$

$$8-2+4-2-7+8$$

$$19-25+49+29$$

$$5-6-3+2+3$$

$$14+38+29-34$$

$$-8+13-9+7$$

$$-3+7 \times 18$$

$$5 \times 4 + 2 \times 4$$

$$-19+(-6)+24$$

$$16+15 \times 2$$

$$35-23-18+11$$

$$4+3+7+4$$

$$52+34+33$$

$$-43+105$$

$$323/19$$

$$8-3 \times 10$$

$$110-63+28-104$$

$$48/32$$

$$22-18 \times 25-3$$

$$61-19/2$$

$$4-(-4)-4$$

$$13+18+17+16+9$$

$$13 \times 56$$

$$12-4 \times 11$$

Appendix G: Demographic questionnaire used in experiment two

We would like to ask you some questions about yourself and your household to see if this affects how people react to stress. Please be assured that all information provided in this study will be kept within the research group and will not be passed on to other parties. Your name will be kept separate from the data you provide.

Please fill in or circle your answers as appropriate.

How tall are you? _____ m / feet, inches

How much do you weigh? _____ kg / st, lb

What is your age _____

What is your date of birth? _____ dd/mm/y

What is your first language(s)? _____

Are there any pets in the place where you live now?.....Yes No

If yes, please specify _____

How would you rate your attitude towards dogs?

Dislike dogs intensely	Do not like dogs at all	Tolerate dogs	No feelings about dogs	Like dogs	Like dogs a lot	Like dogs intensely
---------------------------	----------------------------	------------------	---------------------------	--------------	--------------------	------------------------

Did you have a pet dog in the house as a child?.....Yes No

Are you receiving or have you previously received medical treatment
for high blood pressure?.....Yes No

Have you any heart or circulatory problems?.....Yes No

Have any of these people in your family had high blood pressure:

brothers or sisters	Yes	No	Don't know
mother	Yes	No	Don't know
father	Yes	No	Don't know
maternal grandmother	Yes	No	Don't know
maternal grandfather	Yes	No	Don't know
paternal grandmother	Yes	No	Don't know
paternal grandfather	Yes	No	Don't know

Appendix H: Subjective evaluations questionnaire used in experiment two

What did you think of this experiment? Please circle a number to describe how you felt or your thoughts during the experiment.

1. I viewed the experiment as:

Very Important					Very Trivial
1	2	3	4	5	6

2. I thought the experimental setting was:

Very humorous					Very serious
1	2	3	4	5	6

3. I thought the experimental setting was:

Very formal					Very informal
1	2	3	4	5	6

4. I thought that the experimenter was:

Very intimidating					Very reassuring
1	2	3	4	5	6

5. I thought that the experimental setting for the rest period before the task:

Not at all relaxing					Very relaxing
1	2	3	4	5	6

6. When the blood pressure cuff on my arm was inflated, it was:

Very uncomfortable					Very comfortable
1	2	3	4	5	6

7. How easy did you find it to concentrate on the math task:

Easy to concentrate					Not easy to concentrate
1	2	3	4	5	6

8. On the whole did you find the experimental situation:

Very unpleasant					Very pleasant
1	2	3	4	5	6

Appendix I: Pre-experimental behaviour questionnaire used in experiments two, three and four

There are a number of factors which can influence blood pressure, these include eating, drinking, smoking and exercise. Please could you answer the following questions so that we can assess these factors.

How much **stress** has there been in your life in the past two weeks?

Intense stress	A lot of stress	Tolerable stress	Very little stress	No Stress
-------------------	--------------------	---------------------	-----------------------	-----------

Have you had anything containing **caffeine** e.g. coke, coffee, tea
in the 3 hours before the experiment?Yes No

Have you consumed **alcohol** in the 12 hours before the experiment?Yes No

Have you had anything else to **eat or drink**
in the 2 hours before the experiment?Yes No

If yes, please specify _____

Are you a **regular smoker**?Yes No

Have you **smoked** in the 2 hours before the experiment?Yes No

Have you taken any strenuous **exercise**
in the 3 hours before the experiment.....Yes No

Are you taking any **medication**? (excluding contraceptive pill)Yes No

If yes, please specify _____

Appendix J: Curve fitting to baseline data for different age groups. (data from experiments three and four)

As an extension to the baseline analyses reported in experiment two, further analyses were made on the data from participants in experiments three and four. This allowed examination of a wider range of ages.

Summary of acclimatisation period analyses from experiment three

Age 18-21, mean 19.2, $SD=0.7$, $n=80$

Analysis criteria	Recommended acclimatisation (minutes:seconds)		
	Systolic BP	Diastolic BP	Heart rate
no meaningful decay remaining ($<.5$ mmHg or bpm estimated decay left)	3:43 +	no trends over time	14:23 +
no meaningful decay remaining (95% estimated decay occurred)	4:14 +	no trends over time	13:53 +
highest temporal stability (lowest within baseline SD)	4:00	4:00	6:00
point of no statistical difference in baseline estimates ($p<.05$)	4:00 +	no baselines differ statistically	4:00 +

+ = baselines after or from longer acclimatisation periods exceed / also meet criteria.

Summary of acclimatisation period analyses - experiment four - younger participants

Age 16-38 years, mean 30 years, $SD = 6$ years, $n=34$.

Analysis criteria	Recommended acclimatisation (minutes:seconds)		
	Systolic BP	Diastolic BP	Heart rate
no meaningful decay remaining ($<.5$ mmHg or bpm estimated decay left)	8:35 +	no trends over time	no trends over time
no meaningful decay remaining (95% estimated decay occurred)	9:11 +	no trends over time	no trends over time
highest temporal stability (lowest within baseline SD)	4:00	4:00	4:00
point of no statistical difference in baseline estimates ($p<.05$)	6:00	no baselines differ statistically	6:00

+ = baselines after or from longer acclimatisation periods exceed / also meet criteria.

Summary of acclimatisation period analyses from experiment four - older participants
 Age 40-66, mean 52 years, $SD = 7$ years, $n=33$.

Analysis criteria	Recommended acclimatisation (minutes:seconds)		
	Systolic BP	Diastolic BP	Heart rate
no meaningful decay remaining ($<.5$ mmHg or bpm estimated decay left)	14:18 +	5:59 +	7:00 +
no meaningful decay remaining (95% estimated decay occurred)	12:23 +	8:18 +	11:00 +
highest temporal stability (lowest within baseline SD)	8:00	4:00	8:00
point of no statistical difference in baseline estimates ($p<.05$)	6:00	2:00	6:00

+ = baselines after from longer acclimatisation periods exceed / also meet criteria.

Appendix K: MANOVA in experiment two

A four way multivariate analysis of variance (MANOVA) with dependent variables of systolic BP, diastolic BP and heart rate was used to examine main and reactivity effects. The between-subjects factors were GROUP (control, music, dog); AGE (younger, 18-21 years, older 22-44 years); SEX (male, female); and there was a within-subjects factor of PHASE with two levels (baseline level, task level).

MANOVA N=75	Wilks Λ	F	df	p
SEX	0.58	14.77	3,61	.01
AGE	0.92	1.78	3,61	.16
GROUP	0.96	0.47	6,122	.83
SEX*AGE	0.98	0.33	3,61	.80
SEX*GROUP	0.92	0.84	6,122	.54
AGE*GROUP	0.94	0.61	6,122	.72
AGE*SEX*GROUP	0.98	0.23	6,122	.96
PHASE	0.35	37.60	3,61	<.01
PHASE*SEX	0.98	0.41	3,61	.75
PHASE*AGE	0.98	0.31	3,61	.81
PHASE*GROUP	0.97	0.30	6,122	.94
PHASE*SEX*AGE	0.95	1.19	3,61	.32
PHASE*SEX*GROUP	0.96	0.43	6,122	.86
PHASE*AGE*GROUP	0.96	0.43	6,122	.86
PHASE*AGE*SEX*GROUP	0.93	0.70	6,122	.65

Appendix L: Experimental assessment form used in experiment three

We are very interested to find out what you thought of different aspects of being a subject in this experiment. It will help us if you answer as fully as possible. Your confidentiality is assured as these responses are identified only by a subject number which is not connected to your name.

Please circle a number to describe how you felt or your thoughts during the experiment or answer the open questions as fully as possible.

1. On the whole did you find the experimental situation:

Very unpleasant						Very pleasant
1	2	3	4	5	6	

2. I felt happy and confident about my ability to perform well in the experiment:

Completely agree						Completely disagree
1	2	3	4	5	6	

3. What do you think the purpose of this experiment was?

4. What thoughts were in your mind during the rest period?

5. How comfortable was the blood pressure cuff on your arm when it was inflated?

Very uncomfortable						Very comfortable
1	2	3	4	5	6	

Please tell us what you thought of the manner of the experimenter. Your answers here will be very useful, please feel free to express yourself truthfully.

6. The manner of the experimenter seemed:

Very
professional

1 2 3 4 5

Very
amateur

6

7. I thought that the experimenter was:

Very
intimidating

1 2 3 4 5

Very
reassuring

6

8. I thought that the experimenter seemed:

Very relaxed

1 2 3 4 5

Very
nervous

6

9. I found the experimenter:

Very chatty

1 2 3 4 5

Not at all
talkative

6

10. I felt that for me to talk to the experimenter was:

Very easy

1 2 3 4 5

Very
difficult

6

11. I thought the experimenter was:

Very
friendly

1 2 3 4 5

Very
unfriendly

6

12. The experimenter made me feel:

Very relaxed

1 2 3 4 5

Very much
on edge

6

13. The experimenter was:

Very
likeable

1 2 3 4 5

Not at all
likeable

6

What did you think of the experimental setting?

14. How did you evaluate the experimental setting for the rest period before the task:

Not at all relaxing					Very relaxing
1	2	3	4	5	6

15. How easy did you find it to concentrate on the math task.

Easy to concentrate					Not easy to concentrate
1	2	3	4	5	6

16. How much effort did you put into completing the maths task:

Extreme effort					No effort at all
1	2	3	4	5	6

17. I thought the experimental setting was:

Very humorous					Very serious
1	2	3	4	5	6

18. I thought the experimental setting was:

Very formal					Very informal
1	2	3	4	5	6

19. I viewed the experiment as:

Very Important					Very Trivial
1	2	3	4	5	6

20. Did you feel that the experiment was too long at any point?

Rest Period	Too long	OK
Maths Task	Too long	OK

Additional questions for those in the dog present conditions

21. At what point did you become aware of the presence of the dog in the experimental room?

22. Did you comment on the presence of the dog.....Yes No

23. Why? / Why not? _____

24. Were you expecting to see a dog on the basis of comments from friends or knowledge of the experimenter?

25. My views towards having the dog in the experimental room were:

Disliked it intensely	Did not like it at all	Tolerated its presence	Liked having it there	Liked having it there a lot	Intensely liked the dog
--------------------------	---------------------------	---------------------------	--------------------------	--------------------------------	----------------------------

26. The presence of the dog made me feel:

Very safe					Very unsafe
1	2	3	4	5	6

27. Did you expect to be relaxed by the dog's presence?	YES	NO	DON'T KNOW
---	-----	----	---------------

28. Do you think you were relaxed by the dog's presence in this experiment?	YES	MAYBE	NO
---	-----	-------	----

29. Do you think that generally having a dog around makes you feel more relaxed?

30. Why do you think there was a dog present?

Appendix M: MANOVA in experiment three

The main analysis was a four-way multivariate analysis of variance (MANOVA) with dependent variables of systolic blood pressure, diastolic blood pressure and heart rate. The factors were DOG (presence, absence) and TALK (open or closed opportunity to talk); SEX (male, female); and PHASE with two levels (baseline level, task level).

MANOVA N=80	Wilks Λ	F	df	p
SEX	0.61	14.93	3,70	<.01
DOG	0.96	1.08	3,70	.36
TALK	0.93	1.68	3,70	.18
SEX*DOG	0.94	1.36	3,70	.26
SEX*TALK	0.95	1.31	3,70	.28
DOG*TALK	1.00	0.07	3,70	.98
DOG*SEX*TALK	0.97	0.71	3,70	.55
PHASE	0.49	24.66	3,70	<.01
PHASE*SEX	0.85	4.01	3,70	.01
PHASE*DOG	0.96	1.06	3,70	.37
PHASE*TALK	0.99	0.35	3,70	.79
PHASE*SEX*DOG	0.95	1.23	3,70	.31
PHASE*SEX*TALK	0.95	1.12	3,70	.35
PHASE*DOG*TALK	0.92	2.07	3,70	.11
PHASE*DOG*SEX*TALK	0.95	1.19	3,70	.32

An additional analysis was carried out to examine baseline differences between conditions. Factors were as before: DOG (presence, absence); TALK (open opportunity to talk, closed opportunity to talk); and SEX (male, female).

MANOVA N=80	Wilks Λ	F	df	p
SEX	0.70	9.77	3,70	<.01
DOG	0.92	1.90	3,70	.14
TALK	0.92	2.15	3,70	.10
SEX*DOG	0.97	0.74	3,70	.53
SEX*TALK	0.91	2.33	3,70	.08
DOG*TALK	0.99	0.27	3,70	.85
DOG*SEX*TALK	0.94	1.48	3,70	.23

Appendix N: Univariate analyses of reactivity in experiment three using baseline as a co-variate

Systolic BP	F	df	p
SEX	4.18	1,71	.04
DOG	0.29	1,71	.59
TALK	0.07	1,71	.80
SEX*DOG	0.17	1,71	.69
SEX*TALK	0.13	1,71	.72
DOG*TALK	1.26	1,71	.27
DOG*SEX*TALK	0.02	1,71	.90
BASELINE SYSTOLIC BP COVARIATE	0.70	1,71	.41

Diastolic BP	F	df	p
SEX	0.69	1,71	.41
DOG	1.29	1,71	.26
TALK	0.22	1,71	.64
SEX*DOG	1.02	1,71	.32
SEX*TALK	0.54	1,71	.47
DOG*TALK	0.36	1,71	.55
DOG*SEX*TALK	0.53	1,71	.47
BASELINE DIASTOLIC BP COVARIATE	3.51	1,71	.07

Heart rate	F	df	p
SEX	2.96	1,71	.09
DOG	1.00	1,71	.32
TALK	0.01	1,71	.90
SEX*DOG	1.35	1,71	.25
SEX*TALK	0.14	1,71	.71
DOG*TALK	0.72	1,71	.40
DOG*SEX*TALK	0.89	1,71	.35
BASELINE HEART RATE COVARIATE	<0.00	1,71	.95

Appendix O: Strategy used to allocate participants to conditions in experiment four

A complex strategy was used to compensate for the expected lower number of people who might volunteer to take part in the friend condition and the expected higher numbers of people dropping out in the alone and friend groups. Each potential case was allocated a random number between 0 and 1 and this number determined the condition the participant would be allocated to. The condition this number signified was determined by the ratio of subjects already tested in each condition.

For example, with no subjects tested in any condition, a random number between 0-0.333 would be condition 1 (alone), 0.334-0.667 would be condition 2 (friend) and 0.668-1 would be condition 3 (dog). If the subject had agreed to take part in only conditions 2 (friend) or 3 (dog), then 0-0.500 would be condition 2 (friend) and 0.501 would be condition 3 (dog).

However, if the number of subjects additionally needing to be tested in each condition to bring it up to 21 per condition was 14:17:9, then the 0-1 division would be split in the proportions 12:15:13. If the subject was willing to be tested in any condition, then 0-0.350 would indicate test in condition 1, 0.351-0.775 would indicate condition 2 and 0.776-1 would indicate condition 3.

Appendix P: QRI versions for human companion and canine companion

Directions: Please circle the appropriate number to answer the following questions regarding your relationship with your friend.

Statements	not at all	a little	quite a bit	very much
To what extent could you turn to your friend for advice about problems?	1	2	3	4
How often do you need to work hard to avoid conflict with your friend?	1	2	3	4
To what extent could you count on your friend for practical help with a problem?	1	2	3	4
How upset does your friend sometimes make you feel?	1	2	3	4
To what extent can you count on your friend to be honest and genuine with you?	1	2	3	4
How much does your friend make you feel guilty?	1	2	3	4
How much do you have to "give in" in this relationship?	1	2	3	4
To what extent can you count on your friend to help you if a family member very close to you died?	1	2	3	4
How much do you think your friend wants you to change?	1	2	3	4
How positive a role does your friend play in your life?	1	2	3	4
How significant is this relationship in your life?	1	2	3	4
How close will your relationship be with your friend in years to come?	1	2	3	4
How much would you miss your friend if the two of you could not see or communicate with each other for a month?	1	2	3	4
How critical of you is your friend?	1	2	3	4
If you wanted to go out and do something, how confident are you that your friend would be willing to do something with you?	1	2	3	4
How responsible do you feel for your friend's well being?	1	2	3	4
How much do you depend on your friend?	1	2	3	4
To what extent can you count on your friend to listen to you when you are very angry at someone else?	1	2	3	4
How much would you like your friend to change?	1	2	3	4
How angry does your friend make you feel?	1	2	3	4
How much do you have a battle of wills with your friend?	1	2	3	4
To what extent can you really count on your friend to distract you from your worries when you feel under stress?	1	2	3	4
How often does your friend make you feel angry?	1	2	3	4
How often does your friend try to control you or influence your life?	1	2	3	4
How much more do you give than you get from this relationship?	1	2	3	4

Directions: Please circle the appropriate number to answer the following questions regarding your relationship with your pet dog.

Statements	not at all	a little	quite a bit	very much	not relevant
To what extent could you turn to your dog for advice about problems?	1	2	3	4	n/a
How often do you need to work hard to avoid conflict with your dog?	1	2	3	4	n/a
To what extent could you count on your dog for practical help with a problem?	1	2	3	4	n/a
How upset does your dog sometimes make you feel?	1	2	3	4	n/a
To what extent can you count on your dog to be honest and genuine with you?	1	2	3	4	n/a
How much does your dog make you feel guilty?	1	2	3	4	n/a
How much do you have to "give in" in this relationship?	1	2	3	4	n/a
To what extent can you count on your dog to help you if a family member very close to you died?	1	2	3	4	n/a
How much do you think your dog wants you to change?	1	2	3	4	n/a
How positive a role does your dog play in your life?	1	2	3	4	n/a
How significant is this relationship in your life?	1	2	3	4	n/a
How close will your relationship be with your dog in years to come?	1	2	3	4	n/a
How much would you miss your dog if the two of you could not see or communicate with each other for a month?	1	2	3	4	n/a
How critical of you is your dog?	1	2	3	4	n/a
If you wanted to go out and do something, how confident are you that your dog would be willing to do something with you?	1	2	3	4	n/a
How responsible do you feel for your dog's well being?	1	2	3	4	n/a
How much do you depend on your dog?	1	2	3	4	n/a
To what extent can you count on your dog to listen to you when you are very angry at someone else?	1	2	3	4	n/a
How much would you like your dog to change?	1	2	3	4	n/a
How angry does your dog make you feel?	1	2	3	4	n/a
How much do you have a battle of wills with your dog?	1	2	3	4	n/a
To what extent can you really count on your dog to distract you from your worries when you feel under stress?	1	2	3	4	n/a
How often does your dog make you feel angry?	1	2	3	4	n/a
How often does your dog try to control you or influence your life?	1	2	3	4	n/a
How much more do you give than you get from this relationship?	1	2	3	4	n/a

Appendix Q: Companion demographic questionnaires used in experiment four

Questions about your friend. If you are coming to the study with a friend, please answer the questions thinking about the person you are bringing with you. If you are coming alone or with your dog, then please answer the questions thinking about the person you would have been most likely to ask to come. If there is no-one you think would have been able to come with you, then skip the next section and continue at page 5, questions about your dog.

1. Is your friend male or female? ☐ Male ☐ Female

2. What is your relationship to this person?
friend ☐
spouse / partner ☐
relative ☐ please specify _____

3. How long have you been close to this person?
0 - 6 months ☐
6 months - 1 year ☐
1 year - 5 years ☐
longer than 5 years ☐

4. How would describe your relationship with this person?
extremely close ☐
close ☐
OK ☐
neutral ☐

5. Please list any other people you would have felt able to ask to come with you to this study.

Person (this need not be their full or real name)	Relationship to you

please continue overleaf if necessary

Questions about your dog. Please answer the questions thinking about the dog you would have been most likely to bring if needed or the one who you are bringing.

1. Is your dog male or female?

☐

Dog

☐

Bitch

2. How long have you had your dog?

0-6 months

☐

6 months - 1 year

☐

1 year - 5 years

☐

longer than 5 years

☐

3. What breed is your dog? _____

4. How close would you say your relationship is with your dog?

extremely close

☐

close

☐

OK

☐

neutral

☐

5. Do you have any other pets in the household?

If yes, please give details _____

6. Do you engage in any additional exercise because of the pets you have?

If yes, please give details _____

Appendix R: Experimental assessment form used in experiment four

We are very interested to find out what you thought of different aspects of being in this experiment. It will help us if you answer as fully as possible. Your confidentiality is assured as these responses are identified only by a subject number which is not connected to your name.

Please circle a number to describe how you felt during the experiment.

1. On the whole I found the experimental situation:

Very
unpleasant

1

2

3

4

5

Very
pleasant

6

2. I felt happy and confident about my ability to perform well in the experiment:

Completely
agree

1

2

3

4

5

Completely
disagree

6

3. How did you evaluate the experimental setting for the rest period before the task:

Not at all
relaxing

1

2

3

4

5

Very
relaxing

6

4. How easy did you find it to concentrate on the mirror tracing task.

Easy to
concentrate

1

2

3

4

5

Not easy to
concentrate

6

5. How easy did you find it to concentrate on the computer game.

Easy to
concentrate

1

2

3

4

5

Not easy to
concentrate

6

6. What did you think of the experimental setting:

Very
humorous

1

2

3

4

5

Very
serious

6

7. What did you think of the experimental setting:

Very
formal

1

2

3

4

5

Very
informal

6

How did you feel during the test?

8. I felt isolated and alone during the experiment.

Completely
agree

1 2 3 4 5

Completely
disagree
6

9. I felt helped and supported to do as well as possible during the experiment.

Completely
agree

1 2 3 4 5

Completely
disagree
6

10. I felt evaluated by others during the experiment

Completely
agree

1 2 3 4 5

Completely
disagree
6

11. I thought that the experimenter was:

Very
intimidating

1 2 3 4 5

Very
reassuring
6

12. I thought that the experimenter seemed:

Very relaxed

1 2 3 4 5

Very nervous
6

13. I found the experimenter:

Very chatty

1 2 3 4 5

Not at all
talkative
6

14. I thought the experimenter seemed:

Very
friendly

1 2 3 4 5

Very
unfriendly
6

15. The experimenter made me feel:

Very relaxed

1 2 3 4 5

Very much
on edge
6

16. The experimenter was:

Very
likeable

1 2 3 4 5

Not at all
likeable
6

Additional questions for those in the companion condition. For those in the friend condition, the words 'your dog' were replaced by the words 'your friend' and question 22 was omitted.

17. My views towards having my dog in the room were:

Disliked it intensely	Did not like it at all	Tolerated their presence	Liked having them there	Liked having them there a lot	Intensely liked them being there
--------------------------	---------------------------	-----------------------------	-------------------------------	-------------------------------------	--

18. The presence of my dog made me feel:

Very safe					Very unsafe
1	2	3	4	5	6

19. Concern about how and what my dog was doing made it impossible for me to relax

Completely agree					Completely disagree
1	2	3	4	5	6

20. Did you expect to be relaxed by having your dog with you?

21. How did you feel having your dog with you?

22. Could I also ask you to give me your estimate of your dog's behaviour during the experiment. Please tick the description which you feel most fitted your pet during the experiment. Please disregard the first five minutes which all dogs need to settle down in a strange environment and think about the bulk of the experiment time.

Very well behaved. Quiet and still almost the entire time.	
Quiet and still most of the time with a few whimpers or changes of position.	
Whimpering or moving around frequently. But staying on blanket / beanbag.	
Somewhat unhappy. Trying to get closer to me or moving around a lot, making a lot of noise.	
Seeming very unhappy with the situation. Noisy and or moving around a lot so I felt I needed to settle him / her down.	

Appendix S: Adjective check list used in experiment four

Try to rate the two tasks for how they made you feel. For each word, tick the box to rate the task on a scale from 0 to 5, with 5 meaning it made you feel very much like that and 0 not at all like that and the other numbers feelings in between. If you are not able to remember how the task made you feel, then just leave the section blank.

The tracing the star in the mirror task made me feel ...

	not at all					very much
	0	1	2	3	4	5
Relaxed						
Stressed						
Embarrassed						
Angry						
Confident						
Skilful						
Annoyed						
Frustrated						
Successful						
Frightened						

The computer game task made me feel ...

	not at all					very much
	0	1	2	3	4	5
Relaxed						
Stressed						
Embarrassed						
Angry						
Confident						
Skilful						
Annoyed						
Frustrated						
Successful						
Frightened						

Appendix T: MANOVA on baseline levels in experiment four

An initial MANOVA was conducted on baseline levels of systolic BP, diastolic BP and heart rate with between-subjects factors of SEX, AGE (young, <40 years; old ≥ 40 years) and GROUP (alone, friend, dog) and a within-subjects factor of BASELINE (initial, inter-task).

MANOVA N=75	Wilks Λ	F	df	p
SEX	0.67	8.88	3,53	<.01
AGE	0.82	3.93	3,53	.01
GROUP	0.81	1.98	6,106	.08
SEX*AGE	0.96	0.77	3,53	.51
SEX*GROUP	0.92	0.77	6,106	.60
AGE*GROUP	0.88	1.18	6,106	.32
AGE*SEX*GROUP	0.81	1.93	6,106	.08
BASELINE DIFFERENCES	0.90	1.89	3,53	.14
BASELINE*SEX	1.00	0.05	3,53	.99
BASELINE*AGE	0.93	1.37	3,53	.26
BASELINE*GROUP	0.90	1.00	6,106	.43
BASELINE*SEX*AGE	0.93	1.43	3,53	.24
BASELINE*SEX*GROUP	0.83	1.76	6,106	.11
BASELINE*AGE*GROUP	0.88	1.14	6,106	.34
BASELINE*AGE*SEX*GROUP	0.94	0.55	6,106	.77